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CHOLERA.

CHOLERA:

ITS ORIGIN, HISTORY, CAUSATION, SYMPTOMS, LESIONS, PREVENTION, AND TREATMENT.

BY

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PREFACE.

THE interest awakened in the public and in the medical profession by the possibility of the advent of cholera during the coming summer has led to the publication of this treatise. The subject has always had a peculiar attraction for the author as a teacher and writer, and also because he had the painful advantage of studying it in two epidemics. The occurrence of cholera during 1884 in Egypt and Southern Europe has led to a renewed investigation of its nature, the chief outcome of which has been the theory formed by Dr. Koch and others regarding the material germ of the disease. While declining to accept the doctrines of these physicians as demonstrated, the author seeks to exhibit the specific nature of cholera by evidence drawn from its origin and mode of propagation; to disabuse the medical profession of the erroneous notion that the disease ever originates *de novo;* to maintain the necessity of "quarantine," not in the literal but in the official sense of that word; to point

out the channels through which cholera may be diffused; and to describe the measures which experience has sanctioned to prevent its dissemination and cure those who are attacked by it. For these ends he has spared no pains to prepare a complete but compendious history of the disease as it occurred at different periods and in various countries, while the points most insisted upon are those which relate to its prevention and treatment.

PHILADELPHIA, May, 1885.

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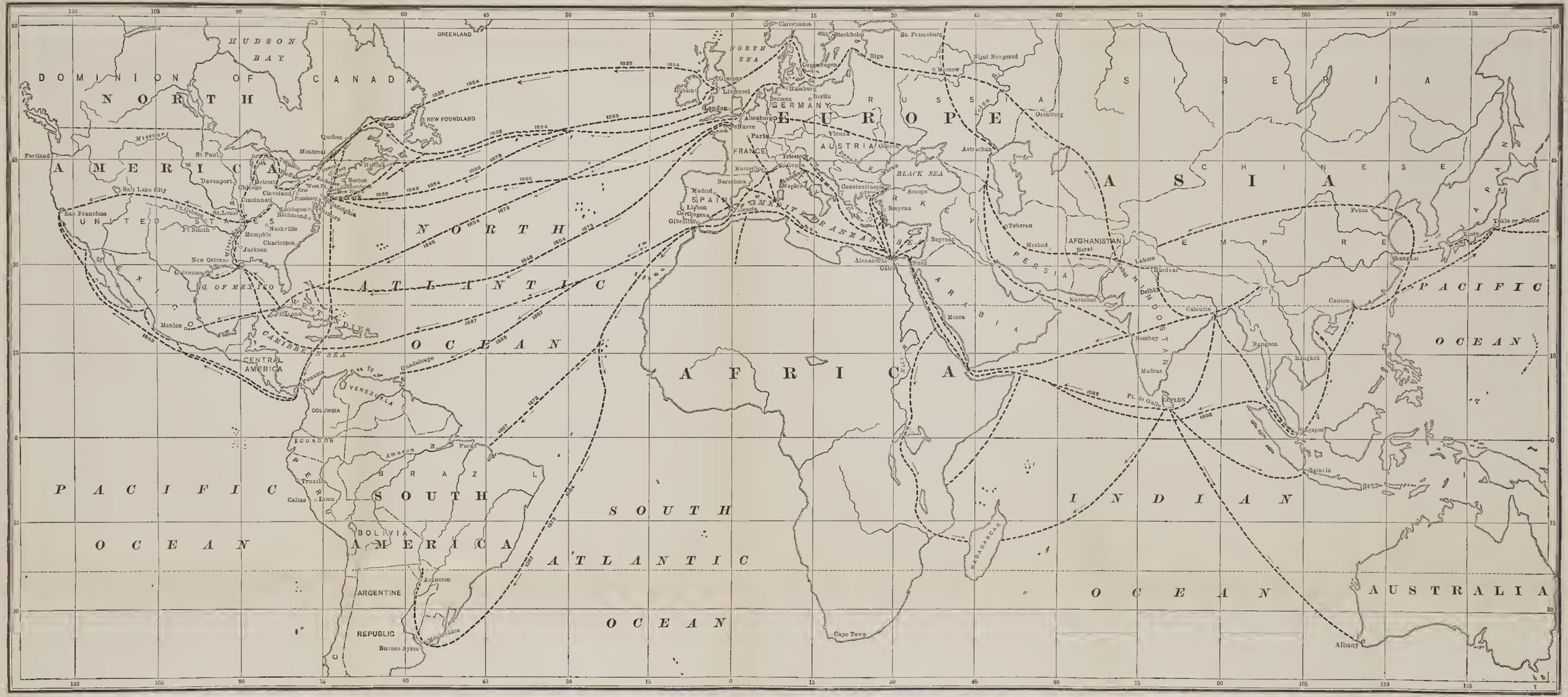
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CHOLERA.

DEFINITION.—Cholera is an epidemic disease, characterized by the transudation of serum into the stomach and bowels, and usually by the profuse discharge by vomiting and purging of a liquid resembling rice-water, followed by a tendency to collapse. It is endemic in India, but has been conveyed thence to almost every part of the world.

SYNONYMS.—Cholera algida, C. asiatica, C. asphyxia, C. maligna, C. spasmodica. In English it is generally spoken of as Asiatic cholera.

HISTORY.

It is sometimes stated that Hippocrates, Galen, Celsus, and the Greek, Roman, and Arabian medical writers generally record "the fact of the presence of cholera in the various countries in which they lived" (Macnamara). Nothing could be more contrary to the truth. All of these writers describe "cholera morbus" in nearly identical terms; they all include bilious discharges among its symptoms, and no one of them speaks of it as a mortal or even as an epidemic disease. (Compare, especially, Celsus, Aretæus, Cælius

Aurelianus, and Paulus Ægineta.) Their description of sporadic cholera morbus is very precise. For example, Cælius Aurelianus says: "Cholericam passionem aiunt aliqui nominatam a fluore fellis, per os et ventrem effecto."[1] Many modern writers have also attempted to identify the "cholera" described by Aretæus with the East Indian disease; and if the enumeration he gives of the spasms, coldness, sweating, syncope, etc. were alone considered, the identification would be complete. But he also notes as prominent symptoms the vomiting of intensely yellow bile, and stools of a similar description. He particularly notes that if the disease tends to death black bile is voided upward and downward. And he adds that children are more liable to the disease than any other persons.[2] Now, the absence of bile from the vomit and stools is the most distinctive feature of Asiatic cholera, and its presence in them, along with the other symptoms mentioned by Aretæus, is equally characteristic of sporadic cholera, cholera morbus, or cholera nostras, as it is variously called. This confusion of two diseases essentially different from each other by reason of the specific cause which generates the one, and the variety of non-specific causes that give rise to the other, has led many otherwise respectable writers upon cholera into an error that taints all their communications upon the subject. And not merely such as relate to ancient epidemics, for they have swept sometimes into the category of "cholera" a variety of affections other than cholera morbus; but in all of them, without exception, are to

[1] *Acut. Morb.*, lib. iii. cap. xix.

[2] *Works*, Sydenham Soc. ed., p. 274.

be found the two symptoms which belong to cholera morbus, and not to cholera—viz. vomiting and purging of bile—and, in addition, a lower rate of mortality than epidemic Asiatic cholera ever produced. Undoubtedly, cholera morbus in its advanced stages is occasionally attended with watery or serous discharges; but when this phenomenon is observed, it is only as an exceptional occurrence.

Asiatic epidemic cholera is a very different disease. It seems to have been known in India from a very remote period, but no detailed account of it was published until the beginning of the sixteenth century. During that century many successive descriptions of the disease exhibited its extreme violence and mortality. It is believed to have occurred repeatedly, if not annually, in the same localities down to the present time. The following account of its symptoms has come down to us: "This dolour struck on the stomach; so grievous was the throe, and of so bad a sort, that the very worst kind of poison seemed to be taking effect, as proved by vomiting, with excessive thirst for water accompanying it, as if the stomach were parched up, and by the cramps that were fixed in the sinews of the joints and in the soles of the feet, with pain so extreme that the sufferer seemed at the point of death. The eyes were dimmed to the sense, and the nails of the hands and feet black and curved. For this disease none of our physicians found a cure. The patient barely lived the day—or, at most, the night—through, in such sort that *of one hundred attacked scarcely ten escaped.* So great was the mortality that the bells tolled all day long." This graphic description was

prepared by the Portuguese physicians at Goa in 1543.

The invasion of India by the Portuguese, and afterward by the English, contributed to spread the disease throughout the Peninsula, partly by military occupation and partly through commercial channels, by which it was also carried to the islands in the Indian Ocean. It prevailed in Batavia in 1629. Bontius, the celebrated naturalist, witnessed its ravages in that island, and prepared a description of the disease, in which, however, he introduces bilious vomiting and purging as characteristic of it, and so leads to the conclusion that he confounded cholera and cholera morbus, as so many later writers have done. Indeed, he distinctly assigns as its cause the extreme summer heat and excessive indulgence in eating fruit. Between 1768 and 1790 numerous epidemics of cholera occurred. About the former date no less than 60,000 persons are said to have perished near Pondicherry, and in 1783 it is reckoned that 20,000 victims to the disease fell in a single week during the religious gathering at the sacred city of Hurdwâr, where, as will be seen hereafter, it became in later years more fatal still. The English armies extended their conquests in Hindostan, and established commerce between that country and Western Asia and Europe, and by the year 1817 opened new channels of communication in every direction, both within and beyond the Peninsula. Along them the disease was carried; it invaded Ceylon and the Burmese empire, and extended to Batavia, Java, and China on the east. In *An Epitome of the Reports of the Medical Officers of the Chinese Imperial Maritime Customs*

Service, from 1871 to 1882, etc., compiled and arranged by Surgeon-General C. A. Gordon, M. D., C. B., London, 1884, it is stated that cholera has been known in China from time immemorial. But, judging by the account furnished of its causes and symptoms, the disease described by the older Chinese authors was probably not epidemic cholera, but cholera morbus. The former disease became known in China about 1669, and again prevailed in 1761 and 1769. On each occasion it was introduced from India. At the same time that it began to spread from the latter country toward the north-west—viz. in 1817—it was also carried in a north-easterly direction to China. In 1820 it appeared at Canton, and reached Pekin the following year. Similar incursions took place in 1826, and also from 1840 to 1843, when they seem to have ceased until 1858, after which the disease prevailed annually for ten years. It was then again suspended, and did not revive until 1877, in which year and in subsequent years it prevailed to a greater or less degree.

The East Indian epidemics of the present century do not appear to have reached Japan until two years after they had invaded China—viz. in 1821–22; but if the Japanese chronicles have been correctly interpreted, an epidemic of cholera occurred in 1718 in the city of Yedo, "the mortality from which exceeded 80,000 a month. The dead were so numerous that their interment was impossible, and their bodies were consigned to the adjoining bay." In 1854, Japan was severely affected by cholera, said to have been imported by the U. S. frigate Mississippi; after which there was no re-

currence of the disease until 1877, when it was introduced by vessels from China. The recorded cases amounted to upward of 12,000, of which rather more than one-half were fatal.

The history of cholera in China and Japan abundantly illustrates the principles or laws maintained in this essay, and confirms the general statement that cholera is one of the most communicable of diseases.

The disease advanced westward to Persia in 1821. In that year also it was carried from Arabia into Africa, and at various later periods penetrated more and more deeply into the Dark Continent, always following the track of pilgrims returning from Mecca, the routes of armies engaged in war, or those of trading caravans.[1]

In these cases, as in others elsewhere, the spontaneous origin of the disease has been assumed by certain writers, but at every stage of its progress careful investigation led uniformly to the conclusion that it was propagated directly or indirectly from pre-existent cases of cholera. From Persia it moved northward as far as the shores of the Caspian Sea, and westward to the Levant in 1823, and there for a time its ravages were stayed. Meanwhile, it prevailed at various places throughout Hindostan, and, assuming a greater degree of violence in 1826, it advanced steadily in a northwestern direction across Afghanistan and Persia in the following year. In 1829 it reached Orenburg, to the north of the Caspian Sea, and was speedily conveyed into the interior of the Russian empire, where it raged

[1] Christie, *Cholera Epidemics in Africa*, 1876.

with great violence in 1830. In 1831 it prevailed at Mecca among the pilgrims, who had brought it from India, and so virulently that one-half of them are computed to have perished. Hence it speedily passed with returning pilgrims to Alexandria and Constantinople, and was carried to St. Petersburg, to Sweden, to Hamburg, and other places in Northern continental Europe. From Hamburg and other seaports it was conveyed to commercial towns on the eastern coast of England, whence it extended to Edinburgh in the north and London in the south.

In 1832 cholera prevailed in France, and within the year caused 120,000 deaths, 7000 of which occurred in Paris in the space of eighteen days. In the spring and summer of that year it was reproduced in England, and extended to Ireland. From Liverpool, Cork, Limerick, and Dublin five vessels filled with emigrants sailed for Quebec, Canada, and they, together, lost 179 passengers by cholera during the voyage.

The immediate results of this importation and first appearance of cholera on the American continent are described by Dr. Peters as follows: "All these ships and their passengers were quarantined at Grosse Isle, a few miles below Quebec. On June 7th the St. Lawrence steamer Voyageur conveyed a load of these emigrants and their baggage, some to Quebec, but the majority to Montreal on the 10th. The first cases of cholera occurred in emigrant boarding-houses in Quebec on the 8th, and the same pest-steamboat, the Voyageur, landed persons dead and dying of cholera at Montreal, a distance of two hundred miles, in less than thirty hours. Over this long distance, thickly

inhabited on both shores of the St. Lawrence, cholera made a single leap, without infecting a single village or a single house between the two cities, with the following exceptions: A man picked up a mattress thrown from the Voyageur, and he and his wife died of cholera; another man, fishing on the St. Lawrence, was requested to bury a dead man from the Voyageur, and he and his wife and nephew died. The captain of a passing boat requested an Indian to bury a man from on board; this man and five other Indians were attacked and died. The town of Three Rivers, halfway between Quebec and Montreal, forbade steamers to land, and escaped for a long time. From Montreal the great influx of emigrants were forwarded away, by the Emigrant Society, as fast as they arrived, and by them the pestilence was sown at each stopping-place. Kingston, Toronto, and Niagara soon became affected. In the end, over 4000 persons died of cholera in Montreal, and more than an equal number in Quebec. The epidemic reached Detroit in the same way, ... and continued west along the Great Lakes, until in September it reached our military posts on the Upper Mississippi. . . . . Fort Dearborn, near Chicago, was temporarily reoccupied in 1832, and it was here that epidemic cholera displayed its most fatal effects among our troops. Out of 1000 men, over 200 cases were admitted into hospitals in the course of seven or eight days. . . . . When these troops again marched for the Mississippi, they appeared in perfect health, yet the cholera broke out again on the way, and when the command reached the Mississippi it had been as fatal as it had been at Fort Dearborn."

We may here for a moment interrupt the narrative of the progress of the disease to note the mode of its dissemination—*i. e.* by communication, direct or indirect, between the sick and the well. The records of this earliest of the American epidemics are full of illustrative examples of its communicability, and from them we select only two or three. The invasion of Detroit has been referred to. The disease was introduced into that city by the United States troops on board the steamboat Henry Clay. The first case on the vessel was a soldier of intemperate habits, who died after an illness of seven hours. Others were soon taken ill. The vessel was ordered away, but on the following day two persons in the town who had been employed to communicate with the boat were attacked with the disease, and one of them died, and on the subsequent days other cases occurred.

In October, 1832, the brig Amelia, with one hundred and eight persons on board, sailed from New York, where cholera was prevailing, for New Orleans. On the sixth day out the disease appeared on board. Later, the brig was stranded on Folly Island, ten miles from Charleston, S. C., and in a day or two afterward the disease began to spread among the inhabitants of the island. The persons employed about the wreck were the first and most severely attacked, and the wreckers in charge of the vessel lost six of their number. Before the Amelia went ashore there had never been a case of cholera within two hundred miles of Folly Island. In July, 1832, at Oneida Castle, twenty-three miles west of Utica, N. Y., an Indian was hired by the captain of a passing canal-boat to bury a man

who had died of cholera on board. He procured other Indians to assist him. He was immediately seized with cholera, and died; and five other Indians were taken, all of whom died. No other cases occurred.[1]

Meanwhile, an emigrant-ship with cholera on board reached New York, whence the disease spread up the Hudson River, and was also carried southwardly to Philadelphia and the West. The mortality in New York City from this epidemic is stated at 3500. In 1833 the disease broke out in the cities of Havana and Matanzas in Cuba, and is said to have destroyed one-tenth of the entire population. Hence it was carried to Mexican and American towns on the Gulf of Mexico, and up the Mississippi and Ohio as far as the western border of Pennsylvania. In the following year it was again introduced at the port of Quebec by a vessel filled with emigrants, of whom many had died during the passage. It prevailed in Canada and the State of New York and spread over the whole country in 1835 and 1836. In the former of these two years it was confined to several Southern cities, whither it was brought, as on a former occasion, directly from Cuba. It then gradually subsided, and at last disappeared for the space of nearly ten years.

But in 1845 it was known to be advancing on its former path, which it steadily pursued, and entered England in October, 1848, at Sunderland, the very town at which it first appeared in 1831. "During the second epidemic in Europe, in 1848, two vessels sailed from

[1] Bernard M. Byrne, M. D., *An Essay to prove the contagious nature of Malignant Cholera* (Baltimore and Philadelphia, 1833).

Havre, where cholera prevailed—one, the New York, for New York, and the other, the Swanton, for New Orleans. Both contained large numbers of German emigrants. On one vessel the cholera appeared when it was sixteen days out, with fourteen deaths; on the other, in twenty-six days, with thirteen deaths. The New York arrived at Staten Island Dec. 2, 1848, and a severe epidemic broke out, but was confined to the quarantine-grounds. The Swanton arrived at New Orleans Dec. 11th; no quarantine was instituted, and in two days its sick were taken into the Charity Hospital. This was the beginning of a severe epidemic, which increased in power all winter, till in June, 1849, 2500 died of it in New Orleans. December 20, 1848, it reached Memphis by steamboat from New Orleans, and for twenty-five days was confined to the landing-place of the former city, whence it afterward spread. In the spring it was carried to St. Louis and Cincinnati and the whole Mississippi Valley. In October it reached Sacramento, Cal., by means of overland emigrants, and, almost at the same time, San Francisco, by the U. S. steamer Northerner from Panama. The Chinese of California suffered most severely" (Peters). In April, 1849, cholera reappeared in the public stores at the quarantine-station, Staten Island, N. Y., and in the city of New York, where it was fatal to 5000 persons.

A pause now took place in the ravages of the disease which lasted until 1853. In that year it destroyed no less than 11,000 persons in the Persian city of Teheran. At Messina its victims numbered 12,000, in France 114,000, and in England about 16,000. In

1854 it was introduced by emigrant-ships into New York, causing a mortality of 2000 persons, and was carried to Philadelphia, where its victims numbered 500. It extended to many towns in New England, and westward along the great channels of emigration. In Montreal the deaths were 1300, and in the then small town of Detroit, 1000.

After an interval of quiescence longer than any previous one the cholera again broke out among the pilgrims to Mecca in December, 1864. It appeared in Alexandria during May, 1865, and thence was carried to many parts of Europe, and from them to North America and the West Indies. "It was at Malta, Smyrna, and Constantinople before the end of June, and appeared in Spain and Italy and at Marseilles during July. Spreading somewhat widely during the next two months, it was at Southampton on September 17, and on November 3 at New York" (Buchanan). The period of exemption above referred to included that of the Civil War in the United States, when, if ever, the local causes which have been erroneously assigned to the disease existed in all their forms and in the most intense degree. It was only when its specific germs were once more imported that cholera began to prevail again. Official records show that in 1866 it was introduced from Europe into Halifax, N. S., the city of New York, and the military posts of New York harbor. Thence it was carried in troop-ships to various Southern ports, from which its progress could be traced to Texas and other Gulf States, and to the towns on the Mississippi and Missouri Rivers. From New York, also, the disease travelled westward to Cin-

cinnati and the U. S. barracks at Newport, on the opposite side of the Ohio River, whence it advanced in a south-westerly direction to meet the trail that, coming from the South, followed the great rivers of the Mississippi Valley. During the summer of 1867 cholera again prevailed, although less fatally, at most of the points, especially of the Mississippi Valley, which had been invaded the previous year, and some cases occurred at the military posts around New York in recruits who had shortly before arrived from places in the West where cholera prevailed. Thus did the disease complete the circuit of the United States.

Meanwhile, cholera prevailed to a greater or less extent in the east of Europe between 1865 and 1874. After the latter date it seems to have been confined to Syria, Arabia, and the African shore of the Mediterranean. In 1877–78 it existed to a limited extent among the pilgrims at Mecca; since then, until 1884, it was unknown in Europe. The latest appearance of cholera in the United States was in 1873, when it occurred at three points far distant from one another. It was introduced in the effects of immigrants. The vessels that brought them were in a perfect sanitary condition. The passengers themselves were healthy, and remained so after landing and until they reached the distant points of Carthage, Ohio, Crow River, Minn., and Yankton, Dak., where their goods were unpacked. At each place, "within twenty-four hours after the poison-particles were liberated, the first cases of the disease appeared, and the unfortunates were almost literally swept from the face of the earth" (E. McClellan).

A steamer from Bankok (Siam), where cholera was prevalent, arrived in 1881 at Hoihow (China). It landed 270 passengers. Soon afterward cholera broke out and was fatal to at least 400 persons, causing about one death in every three houses. It was remarked that the Cantonese who dwelt there were less affected than the natives, and their exemption was attributed to their more cleanly habits of living, especially in the use of water.[1]

In 1881 cholera was brought from Hindostan to Arabia by pilgrims on their way to Mecca, where it soon afterward broke out and caused the death of about 8000 persons. In the following year several vessels from Bombay evaded the quarantine and arrived at Djeddah, the port of Mecca, and the pilgrims on reaching the latter city disseminated the disease. The unusually small number of persons who were there at the time, and their prompt dispersion before the danger, limited the mortality, and gradually cases of cholera ceased to appear. In 1882, the English at that time carrying on war in Egypt, very rigid sanitary precautions against the importation of cholera were enacted and successfully enforced, but in the following year, the same urgent necessity no longer commanding, they were considerably relaxed. At the end of June, 1883, the cholera made its appearance at Damietta (at one of the mouths of the Nile), and soon afterward at Rosetta, Port Saïd, and Mansourah. During July it spread to various places in direct communication with those named. At Cairo it was peculiarly fatal, and on July 20th it was reported to have caused

[1] Aldridge, *Times and Gazette*, January, 1883, p. 18.

600 deaths. For several days the daily mortality varied between 500 and 600. The disease prevailed somewhat in Alexandria during the height of the epidemic, and near the end of October it was fatal to numerous European residents of that city, and some deaths occurred in the British army of occupation. In all Egypt, during the week ending Aug. 13th, the total mortality is said to have been 5000, but in the following week it fell to 2000. It is estimated that from the 22d of June to the 1st of September, 1883, the cholera destroyed at least 50,000 lives. The germ of this epidemic has not been accurately determined. Some regard it as a survival of the cholera of the previous year—a supposition which is at least plausible and sufficient; but certain "sanitarians" have attributed the outbreak to the ordinary causes of disease intensified by the civil war which had recently devastated Egypt. It is sufficient here to say that while such causes have in all ages generated typhus and typhoid fevers and dysentery, they never produced cholera. Some, more unwise than judicious, declared that the Egyptian disease of 1883 was not cholera. It is alleged, on the one hand, that several East Indian merchants from Bombay arrived at Damietta on June 18th, or three days before the disease was recognized in that city. It is also said that a stoker from on board an English steamer from Bombay introduced the cholera into Damietta. But the judgment of Surgeon-General Murray carries with it greater weight.[1] He is of the opinion that the Egyptian epidemic of 1883 was simply a revival of the Arabian epidemic of 1882. He shows

[1] *Times and Gazette*, Feb., 1884, p. 209.

that cholera existed in several villages on the Damietta branch of the Nile in the latter part of May and during June, and that it broke out in the capital itself, during a fair which had lasted for eight days, on the 22d of June, and was spread by the people on their return from Damietta to their villages. This, adds Mr. Murray, "is a literal transcript of the accounts of many of the severe epidemics that have raged over India." Dr. Peters describes with more detail the mode of origin and extension of this epidemic.[1] At Damietta and Port Saïd at least 15,000 people congregated, in addition to the 35,000 inhabitants, to attend a great fair. The barbers who shave and prepare the dead are the first registrars of vital statistics in many Egyptian towns, and the principal barber of Damietta was among the first to die of cholera; and hence the earliest records of deaths were lost. The water-supply of Damietta is obtained chiefly from a canal connecting two branches of the Nile. Mosques and many houses are on the banks of this canal, and their drainage goes into it. Every mosque has a public privy, and also a tank for the ablution which Mohammedans must practise before entering a holy place. There was, of course, great choleraic water-contamination, and a sudden outburst of cholera took place. Only when the strangers had fled from Damietta, panic-stricken, was a rigid quarantine established and a cordon put around the town "to keep everybody in and let no one go out, neither food, nor medicines, nor physicians, nor supplies of any kind."

[1] *Med. Record*, xxvii. 288.

It appears from M. Proust's narrative[1] that the Ottoman government had already, as early as April, notified the government of Egypt that certain Indo-Javanese pilgrims were on their way to Mecca, and that they ought not to be allowed to land without quarantine. The French delegate to the sanitary council also begged that those of the pilgrims who reached Suez without previous quarantine should be isolated and kept under surveillance for three days. But owing to the opposition of the English delegates these measures were not duly enforced, the council did not meet again, and no protective system was adopted.

About the end of June, 1884, it was announced by telegraph that an outbreak of cholera had taken place at Toulon, the great naval entrepôt of France upon the Mediterranean, and soon afterward a similar announcement was made of the appearance of the disease in the neighboring city of Marseilles. The infection was alleged to have been brought from China to Toulon in a transport vessel, La Sarthe, whose commander was reported to have committed suicide, owing to mental distress caused by his relation to the disaster. Drs. Brouardel and Proust, however, who were deputed by the French government to investigate the matter, reported to the Academy of Medicine that no blame could be attached to that unfortunate vessel, and that the first case of cholera occurred at Toulon June 14th, and the second on the following day, on board the Montebello, a ship that had been lying in port for fifteen months. But Dr. Koch, so well known by his investigations into the causation of cholera, is reported

[1] *Le Cholera*, 1883.

to have spoken as follows upon this point: "I think I may say that, considering the precautions taken by the naval authorities, cholera was imported on some merchant-ship, probably English. They do not scruple on English vessels to hide deaths which occur on voyages or to falsify logs."[1]

An ungovernable panic seized upon the inhabitants of Toulon and Marseilles, and 6000 persons are reported to have quitted the former city. On the 22d of June a boy attending a grammar-school in Toulon died of cholera, after which the disease rapidly became epidemic. The commissioners were unable to determine how the disease was introduced among the civil population, but they distinctly traced its dissemination by the sick, as in the following instance: "Two cases of cholera occurred at La Valette, a healthy village four miles distant from Toulon, in which a laborer coming from the latter place had died of cholera a few days before. As the two persons referred to had not for several months gone to Toulon, they apparently had contracted the disease from the first patient who died at La Valette."

During the first week in July it was reported that eight or ten deaths occurred daily in the navy-yards of Toulon and in the town; at the naval hospital there were sixty-two cholera patients. On the 6th of that month nine deaths from cholera took place at Toulon and sixteen at Marseilles, besides twenty cases that were carried to the hospital. For the week ending July 22d there were reported 175 deaths from cholera at Toulon and 338 at Marseilles, while the disease ex-

[1] *Med. News*, xlv. 84.

tended to several neighboring places, and some cases of it occurred at Arles and Lyons. In all between 800 and 900 fatal cases occurred in Toulon, and 1700 in Marseilles. A steamer from Marseilles, which arrived at Liverpool July 18th, is said to have had two deaths from cholera during the voyage.

A despatch from Marseilles of July 29th gives the number of deaths from cholera to that date as 1147, and another despatch of August 2d states the total mortality at 1248. From the commencement of the epidemic the inhabitants of the two cities in which the disease prevailed were seized with a panic, and every one who was able to escape fled from them. When, later, the victims of the disease had become more numerous, the inhabitants of other places refused to receive the fugitives. It is said that the people of a village near Béziers, headed by the mayor, drove off and stoned the refugees from Marseilles. No doubt, however, the disease was more or less disseminated by such persons in France, and also in Italy, for on July 30th eight deaths from cholera were reported, and on August 2d twenty-seven cases, with twelve deaths, were said to have occurred at two villages in Italy. A little later the disease broke out in the southern provinces, and Naples and Spezia appear to have suffered most severely. The total number of deaths in the former city is reported to have been 6842, and the highest daily mortality 365. About the same time the disease prevailed in Genoa, and produced at least 1168 cases and 617 deaths; and the total number of fatal cases in Italy was about 10,000. The port of Huelva in Spain was also declared to be infected, and the

ports of Cadiz and Agamonte were suspected of being so; but the disease was confined to the south-eastern coast-line. From July 30th the number of deaths from cholera in Toulon and Marseilles began to decline, and by August 2d had so nearly ceased in the latter city that no deaths from it were reported. The people are said to have returned in great numbers, and the streets were assuming their normal aspect of gayety, and, according to the despatches, "physicians believed that the cholera would disappear from the city in a few days." The grounds of such a belief are not apparent, especially while the city was being filled again with its self-exiled population. Indeed, this increase of subjects was immediately followed by an increase in the number of deaths from cholera, which also occupied a wider area both in France and Italy. Under date of August 9th it was reported by telegraph that "the English cholera had appeared in several districts of Lancashire, and is making considerable headway. The number of persons stricken with it exceeds two hundred, and five deaths have so far occurred." The nature of this epidemic is open to question.

The action of the authorities in various countries demonstrates the widespread belief in the communicability of cholera by the sick to the well. At a meeting of the Cabinet, held at Washington July 18th, a proclamation was authorized, and subsequently published by the President, enjoining vigilance and a strict performance of duty on all customs and health officers, and the examination at sea of all vessels from ports where infectious or contagious diseases prevailed at

the time of their sailing. About the same date the governments of nearly all European countries adopted measures to prevent the introduction of cholera by persons or merchandise. Not only were quarantine regulations at seaports applied as strictly as possible, but even the mountain-passes and other highways were watched to prevent the passage of infected persons. Indeed, so stringent were the sanitary regulations that travel and commerce were greatly interfered with, and in some places suspended altogether. On the other hand, the noxious and absurd practice of fumigating travellers with burning sulphur was generally abandoned.

According to a telegram dated Berlin, July 30th, "Dr. Koch had addressed his report on the epidemic to Prince Bismarck. He criticises severely the want of precaution shown by the English government in taking measures to prevent the spread of the epidemic. Should the cholera appear in England, Dr. Koch advises that the strictest measures should be adopted against all vessels sailing from England."

ETIOLOGY.

The essential cause of cholera is unknown, unless the investigations of Koch, described below, may have revealed it. Its secondary causes, or the conditions of its dissemination, are better understood. Some general propositions concerning them will here be laid down, and illustrated so far as the argument requires and the available space will allow.

Cholera is endemic in no other country than India, and more particularly in Bengal. When it has occurred elsewhere it has invariably been carried from India. At the cholera conference held at Berlin in 1884 a question was distinctly formulated, thus: "Is cholera generated by a specific infectious material which comes from India only?" Professor Virchow remarked that there could scarcely be a discussion of this question in Germany; at least, he did not know that any noteworthy attack upon the truth of this proposition had been made in Germany in the last decade. No dissenting opinion was expressed. The cholera-poison has been imagined to be of an aërial nature, but its diffusion has no relation whatever to the velocity or the direction of the wind. In no instance whatever has its rate of progress exceeded that of man on land or water, nor has it ever taken a direction different from that of commercial or military movements. On land it has usually crept from place to place, and if sometimes it has seemed to leap across wide spaces, and even seas and oceans, it has never invaded any inland town or seaport without having been brought thither from a point already affected with the disease. Nor, having once entered an inland or seaboard town, does it spread equally therein in all directions, but prevails chiefly in the quarter immediately surrounding the place of its entrance. If appropriate sanitary measures are enforced, it is sometimes confined to that quarter, and in the case of quarantine-stations it has repeatedly been prevented from extending beyond them. This statement may be illustrated by the fact that of fourteen epidemics of cholera at

Staten Island, the quarantine-station of New York, all but four were prevented from reaching that city.[1] When the disease does overleap the barrier opposed to it, its origin and subsequent course can usually be traced.

A high atmospheric temperature is everywhere associated with the prevalence of cholera. Its origin in the hot climate of Hindostan and its general progress prove this conclusively. In nearly all of the places where a great difference exists between the summer and the winter temperature the disease has disappeared during the cold season, and attained its greatest intensity during the hot months of the year. The only apparent exception to this rule is, that cholera has prevailed in several Russian, Swedish, and Norwegian cities during the winter. But these very exceptions confirm the rule; for in the countries mentioned the intense cold of the winter compels the inhabitants to seal their houses by every possible means, while the atmosphere within them is kept at a high temperature by huge stoves, which hinder ventilation, and indeed render it almost impossible. Difference of temperature likewise explains the fact that of two cholera-ships arriving from Havre, the one at New York and the other at New Orleans, in December, 1848, the former did not disseminate the disease, but the latter formed the starting-point of an epidemic which lasted all the winter.

A good deal has been written of the predisposing causes of cholera, and poverty, crowding, filth, intemperance, and depression of spirits have been given

[1] Peters's *Notes, etc.*, 2d ed., p. 94.

prominent places in the catalogue. But to any one familiar with the history of epidemic diseases it will at once be apparent that every one of these conditions favors the spread of all communicable infectious diseases. There is not the slightest evidence that these agencies, singly or combined, can generate cholera or favor its spread apart from the presence of the specific poison of the disease and the facility with which it is transmitted from the sick to the well whenever the population is crowded, poor, of filthy habits, and weakened by dissipation. Because among such people intemperance prevails, this vice has been regarded as predisposing to cholera. Apart from the brutish mode of living of drunkards, there is nothing to show that they are more liable to cholera than the most abstemious of water-drinkers. On the contrary, it is notorious that during cholera epidemics drunkards in the better classes of society enjoy a certain degree of immunity from the disease; which it is easy to explain on the ground that they imbibe but little water, which is the main channel through which the infectious principle of the disease is spread.

The specific cause of cholera is taken into the alimentary canal, and acts through it to produce the characteristic symptoms of the disease. It is conveyed from the sick to the well by means of the gastro-intestinal discharges, either moist or dry; in the former state, by means of drinking-water, and in the latter through the air, whose suspended noxious particles are received into the fauces and swallowed. There is reason to believe that the poison does not enter the system through the lungs, or through any other chan-

nel than the gastro-intestinal canal. W. B. Carpenter[1] appears to hold, however, that the poison may be absorbed through the lungs. To this view there are two objections: 1, That whatever is taken into the mouth or throat by inspiration may very well be swallowed; and, 2, that all the primary lesions of cholera affect the digestive and not the respiratory apparatus. It is not at all necessary to the propagation of cholera that its excreta should be furnished by persons laboring under the fully-formed disease. A specific choleraic diarrhœa is as infectious as the evacuations which occur in completely developed cholera. But neither will propagate the disease through the air to a distance. The tendency to its propagation in this manner depends chiefly upon the concentration of the poison; thus, it much more frequently occurs in close than in well-ventilated rooms or than in the open air. It has been argued that cholera is not contagious, because so few, comparatively, of the attendants upon cholera patients contract the disease. On the other hand, as some of them are attacked, this positive fact outweighs an indefinite number of negative instances. It should also be noted that different diseases enter the system and infect it through different channels—some through the lungs, others through the alimentary canal, etc. Small-pox, the most contagious of all diseases, is introduced through the air-passages, and is probably harmless when its virus is taken into the stomach. That the converse of this proposition applies to cholera is sustained by the whole history of the disease. Cholera-poison may be taken to considerable distances in

[1] *The Nineteenth Century*, Feb., 1884.

either a moist or a dry condition. In the former state it is mainly conveyed by water, as in rivers, water-pipes, etc.; in the latter, by fomites, and especially by clothing saturated or merely soiled with cholera discharges, and which may retain their infectious quality for an indefinite time.

Great stress has been laid upon the humidity and foulness of the soil, a damp atmosphere, filth, crowding, etc., as elements in the production of cholera, but in reality they have no more essential relation to it than to any other disease that occurs epidemically. Cholera may prevail whether they are present or absent. It is evident that from the earliest historical periods all of these causes of disease have existed, and in Europe much more generally and excessively than during the present century, and that they have never been removed in Asia Minor, Egypt, Arabia, and Africa. Yet cholera never was known in any of these countries until it was brought into them about the end of the first third of the present century.

According to Pettenkoffer, cholera is most prevalent when the subsoil water is lowest, and least so when the subsoil water is highest. It would be more descriptive of the fact to say that, so far as cholera has anything to do with the condition of the soil, it is most apt to be severe and prevalent when very dry weather follows a very wet period. Such circumstances are the most favorable to putrefactive fermentation and the dissemination of its products, which thus reach wells of drinking-water, and even rivers, especially when sewers empty into the latter. The identity of this explanation with that which is generally accepted for

the dissemination of typhoid fever is too evident to be insisted upon. We might go farther, and say that, in typhoid fever as in cholera, the disease is communicated, although exceptionally, by the air of the sick room and by the exhalations of the soiled fomites of the patient. Now, if typhoid fever resembled cholera not only in being transmitted by means of the dejections, but also in its poison being derived from one primary source only, the analogy between the causes of the two diseases would be very striking indeed. But, in point of fact, the typhoid-fever poison may probably be generated de novo by fecal fermentation and other forms of putrefaction, and the disease is only exceptionally communicable; whereas, the poison of cholera, once received, is conveyed from man to man and far and wide through various channels; but, so far as is known, it has but one primary source, and that is in India. Lebert states that he did not find the localities that are the ordinary seats of typhoid fever peculiarly liable to invasions of cholera. But it must be noted that typhoid fever is very far from being exclusively a disease of the poor, squalid, and vicious. Like death itself, "regum turres pauperumque tabernas æquo pede pulsat;" while cholera much more commonly plants itself and disseminates its seeds in the rank soil of moral and physical degradation.

All morbid causes whatever, derived from race, climate, religion, dwellings, food, clothing, habits of living, etc., have no more to do with the development of cholera than with that of the eruptive fevers, and even less than with the causation of typhus and typhoid fevers and dysentery. The eruptive fevers are

caused, as cholera probably is, by specific germs which no known combination of natural causes has ever developed, while the poisons of the other diseases named appear to be generated anew whenever certain more or less definite physical conditions coexist. It would seem that cholera differs radically from all of these affections by the fact that its cause does not enter the circulation, but confines its direct operation to the gastro-intestinal mucous membrane. In this way it becomes intelligible that while, on the one hand, physicians and nurses of cholera patients, although often, in fact, yet in relation to their numbers, are comparatively seldom, affected, provided they duly observe proper sanitary rules, the disease, on the other hand, spreads like wildfire among those who drink water polluted by cholera excretions, and only a little less rapidly among people crowded into ill-ventilated apartments along with cholera patients.

The special fomites of the cholera-poison are articles of clothing and furniture soiled with the discharges of the sick, and the emanations from privies, sewers, etc. into which these discharges have been cast. Many considerations render it probable that a very small quantity of cholera matter may suffice to render infectious a very large quantity of liquid, and especially of matters in process of putrefactive fermentation, and that the gaseous or vaporous emanations from them become diffused in the atmosphere and infect all who imbibe them. But water contaminated by cholera discharges is the most rapid and efficient agent in disseminating the disease. Innumerable instances of this mode of action are furnished by its history in

Asia and Africa, where water is often scarce, and naturally so impure that its additional defilement by cholera dejections is apt to pass unnoticed. From the illustrations of this proposition which might be adduced only a few of the more striking will here be selected.

Hurdwâr is a town in Northern India at the base of the Himalayas, where the Ganges begins its course in the plains. It is the seat of a great Hindoo pilgrimage, which takes place annually in April, when sometimes from 2,000,000 to 3,000,000 of people occupy an encampment of about twenty-two square miles, comprising a low flat island in the Ganges and the opposite banks of the river. Bathing in the sacred stream on a certain day is the main object of the devotees; which day in the year 1867 fell on the 12th of April. The bath was taken early in the morning. From noon on that day the pilgrims began to disperse so rapidly that on the morning of the 15th the encampment was quite deserted. It appears that up to the former date the health of the encampment was excellent, and it was the opinion of the reporter (Dr. Cunningham) that cholera was introduced into the camp by pilgrims from the neighboring districts going late to the fair. He believed that the cholera excreta may have been buried in the trenches and carried by a heavy rain into the river, and there swallowed by the pilgrims; for to drink of the water of the Ganges as well as to bathe in it is a religious obligation.

Immediately after the breaking up of the camp cases occurred in the surrounding districts, the epidemic widening in all directions. The pilgrims were almost

always the first persons attacked in any locality, and the cholera attended them on their route wherever they went. In all the districts where the disease prevailed no cases occurred until ample time had been given for the pilgrims to reach them. In a word, "the cholera first showed itself among them; it followed their lines of route only, and did not outrun them; their progress was its progress, and their limits its limits." The mortality caused by this epidemic among the whole civil population of the North-western Provinces of the Punjâb has been estimated at about 117,181.[1] The history of the religious festival of 1879 was identical with that just sketched, except that the number of the pilgrims was smaller and the deaths proportionally less.[2]

Out of the numberless illustrations of the manner in which cholera is disseminated by water the following may be cited: In 1865 about 100,000 pilgrims were assembled at Mecca, of whom from 10,000 to 15,000 fell victims to the disease, two-thirds of them within a period of six days. Some cause acting simultaneously upon the whole number of persons must be admitted to account for so extraordinary a fact, and such a cause is not far to seek. At a certain sacred well "one hundred thousand people had skinfuls of water poured over them at the side of the well, and every one of them then drank largely of water drawn from the well. Much of the water poured over the pilgrims must have found its way by soakage back into the well, and if any of the pilgrims were at the time suffering

[1] *Brit. and For. Med.-Chir. Rev.*, Jan., 1870, p. 137.

[2] Murray, *Practitioner*, xxvi. 309.

from cholera, or had cholera-tainted garments about them, the well would be exposed to pollution."[1]

In the cholera epidemics of Zanzibar the disease produced the greatest havoc among the negroes, the Persians, and the East Indians; very few Europeans were attacked, and quite as few of the sect of the Banyans, who drank only water drawn from their own wells. The persons among whom the disease prevailed so fatally used chiefly the water of a certain well which was highly prized, but which on this occasion had become polluted by soakage from an adjacent cesspool into which the dejections of cholera patients had been thrown. It appears, also, that in Zanzibar the streams are very rarely bridged, and hundreds of negroes, in passing backward and forward, wade through them and pollute them. In these streams, also, the negroes wash their clothes and all the foul clothing of the contiguous town. While this business is going on "a gang of negroes may be at work at not many hundred yards' distance filling water-casks for the shipping." Subsequently to the watering of the ships in this manner sailors were attacked with cholera, and others who used water drawn from the stream below the place where it became polluted were attacked, and many of them died; while Europeans living on shore, and who drank the water of the same stream, but drawn from a much higher point in its course and after having been filtered, escaped the disease.[2]

The history of the disease in Europe furnishes a multiplicity of similar cases, and even more distinctly

[1] Christie, *Cholera Epidemics in East Africa*, p. 488.

[2] *Ibid.*, pp. 320, 492.

exhibits the dissemination of cholera by contaminated water.[1] In Holland not less than five epidemics of the disease occurred between 1832 and 1869, all of them causing a great mortality, to which the epidemic of 1866 alone contributed not less than 20,000 deaths. This was about 55 deaths for every 10,000 inhabitants. Such exceptional mortality over so wide a territory has been ascribed to the extreme porosity and humidity of the soil, which is nearly all below the level of the sea. Such a soil must necessarily retain longer than other soils whatever it absorbs, and thus tend to render the well-water habitually impure, If, then, to the ordinary impurities a specific poison is added, its characteristic effects may assuredly be looked for. The conditions now stated explain the conclusions of Ballot of Rotterdam, drawn from a study of the several epidemics referred to. They are as follows: "1. Holland is highly affected by the cholera at every epidemic, chiefly in those parts where they drink water directly from the rivers and canals or from ground saturated with sewage. 2. In places where rain-water is generally drunk the disease is far less violent. 3. Places where there is no other drinkable water but rain-water are not affected by the epidemic; the single cases occurring there are imported. 4. When places affected by the cholera were supplied with pure water instead of the vitiated water the disease disappeared."[2]

[1] It is of interest to note that on the first appearance of cholera in England, at Sunderland, in 1831, a surgeon of that place, Mr. Ainsworth, collected and published conclusive proofs of the importation of the disease, of its communication from the sick to the well, "and of its propagation by clothes, and even by emanations, from the dead" (*Observations on the Pestilential Cholera*, London, 1832).

[2] *Med. Times and Gaz.*, May, 1869, p. 459; June, 1869, p. 626.

In like manner, we find that the cholera epidemic of 1873 in Germany seemed specially to select those situations where the subsoil was impregnated with decomposing organic matter; and it is evident that, in cities especially, such situations would include the most poverty-stricken districts, while the higher, drier, and at all times more salubrious localities are inhabited by the classes enjoying the greatest material prosperity.[1]

Similar results of observation were obtained during the European epidemic of 1884. In a communication made to the French Academy by M. Proust he stated that the physicians charged with the study of epidemic diseases in several departments had made reports from which the following conclusions were to be drawn: 1. Cholera was imported into the places where it prevailed; 2. Water was an important agent in transmitting it; 3. The severity of each epidemic was proportioned to the insalubrity of the place where it occurred; 4. The cessation of the epidemic in the affected places may be attributed in part to the hygienic measures and the disinfection employed.[2]

This mode of infection has been traced in numberless individual cases of cholera. In London there was a certain well into which the liquid contents of a sewer had been percolating for months. Of the water of this well hundreds of persons had been drinking without obvious injury. At last a case of cholera occurred hard by; the discharges were thrown into a privy which communicated with the sewer and indirectly with the well, whereupon more than 500 persons who

[1] "Report of the German Imperial Commission," *Practitioner*, xxvi. 153.

[2] *Archives gén.*, March, 1885, p. 372.

drank water drawn from that particular well were attacked with cholera within three days. So in 1856 cholera prevailed in the county jail of Oxford, Eng., the drain from which emptied into a pool from which the water was drawn to supply the city prison. In the latter institution cholera began to prevail, but declined as soon as the pipes conveying the water were cut off, and soon afterward ceased entirely.[1] Again, in Constantinople in 1865 the clothes, mattresses, etc. of cholera patients were washed at a fountain the basin of which was divided into two parts by a wall; one part was used for washing clothes and the other for drinking purposes. Unfortunately, the waste-pipe of the former being obstructed, the foul water of one side communicated with the clean water of the other, and in one day 60 people died of cholera in the small portion of the city which was supplied from the infected source. The striking case has often been cited which occurred at Epping, Eng., where a woman brought the disease from a distance into a perfectly healthy house and neighborhood, and of ten persons affected with it seven died, including a physician in attendance upon one of them. An examination of the premises "discovered, below the pipes leading from the water-closet and from the eye-hole of the sink through which the choleraic dejections had been passed, a leakage which extended under the foundations of the building and entered the well. The sewage was distinctly traceable on the side of the well corresponding with the leakage in the drain." After this discovery and the disuse of the foul water not another case occurred.[2]

[1] *Edinb. Med. Jour.*, i. 1122. [2] *Trans. of the Epidemiological Soc.*, ii. 428.

In 1868, Dr. Farr, in his *History of the London Cholera Epidemic of 1866*, showed that water into which cholera dejections find their way produces cases of cholera all over the district in which it is distributed for a certain period of time, and that if the distribution is in any way cut short the deaths from cholera begin to decline within about three days of the date at which the distribution is stopped.[1] Among the most recent examples which illustrate the diffusion of cholera by means of drinking-water is that presented by the epidemic at Genoa in 1884. It was remarkable for not being confined to any one quarter or to the most insalubrious portions of the city. The verdict of experts appointed to investigate the subject was that the spread of the epidemic in all parts of the city was caused by impure water. It was understood, although not so officially reported, that out of 68 cases of cholera during the first three days after its appearance there were 61 deaths, and that all of these victims had used the water brought from a certain aqueduct. It was also observed that fish died in fountains supplied by the water alluded to.[2]

Analogous instances are furnished by every cholera epidemic of which the history has been accurately observed, including that which extended so widely over the United States in 1873. Most of the following are cited from the official reports prepared, under the direction of the Surgeon-General of the army, by Surgeon Ely McClellan and Dr. John C. Peters. Several of the first cases, however, are foreign.

[1] *Lancet*, April, 1868, p. 217.

[2] *Medical News*, xlv. 474.

In 1861, at a station in India, some fresh cholera dejecta found their way into a vessel of drinking-water. Early on the following morning a small quantity of this water was swallowed by nineteen persons, five of whom were attacked with cholera between the first and the third day afterward.[1] In 1876 an outbreak of cholera took place in a village in Hindostan, which followed the arrival of wedding-guests, one of whom was attacked, and from whom it rapidly spread. The soiled clothes of one or more of the patients were washed in a pool from which all the villagers obtained their drinking-water, and on the discontinuance of this source of water-supply cholera speedily diminished in frequency and fatality.[2] In the German epidemic of 1873 many cases occurred where persons deriving their drinking-water from special sources were attacked with cholera, while their neighbors, supplied from a different source, remained free. Again, it has frequently happened that outbreaks of cholera have been checked by the prohibition of the suspected water and the substitution of a pure supply.[3] It seems probable that a very small portion of cholera discharges suffices to infect a very large body of water and maintain its infectiousness for a considerable time.

In December, 1871, an outburst of cholera occurred which was confined to the inmates of three excellent houses in a fine block of buildings in Calcutta. There had been no cholera in that neighborhood for four years. Within forty-eight hours a majority of the

[1] Macnamara, *op. cit.*, p. 196.

[2] Surg.-Major Cornish, *Practitioner*, xxiv. 215.

[3] *Practitioner*, xxvi. 159.

lodgers were sick, and on investigation it was found that the disease was carried in the drinking-water and in the milk diluted with it.[1] The particular locality in which Dr. Koch made the discovery of the microscopic representative of cholera furnishes an example of the same nature: "At Saheb Ragau, a locality which has repeatedly been visited by cholera during the last hundred years, numerous cases of the disease were reported, and these, on inquiry, were found exclusively in the huts situated round a certain tank. Of the few hundred people who dwelt in these huts, as many as seventeen died of cholera, though the disease was not at that time prevalent in the neighborhood, or indeed in the whole police district of Calcutta. It was proved that, as usual in such cases, the dwellers around the tank used it for bathing, and drew thence their drinking-water; it was also elicited that the linen of the first fatal case, befouled with cholera dejections, had been washed in the tank."[2] In June, 1873, a new hotel was opened at Vienna, and many of the guests became affected with diarrhœa that was attributed to the drinking-water, which was offensive to the taste and smell. After a fortnight a gentleman died of cholera in the hotel, and two days later several of the guests were attacked with the disease, of whom fourteen died. The gentleman who first died was believed to have brought the poison with him into the hotel, so that the drinking-water, which previously had been polluted with ordinary fecal discharges, became specifically affected through him.[3] The discharges of one ill of cholera

[1] *U. S. Report*, p. 85. [2] *Times and Gaz.*, April, 1884, p. 527.
[3] *Ibid.*, p. 86.

were thrown into, and the vessels used by him were washed near, a well from which all the residents of a farm-house drank. The wooden curbing of the well had rotted, and the ground immediately around had sunken; a heavy rain burst the curb, overflowed the well, and washed into it the entire surface-drainage of the surrounding ground. No attention was paid to this, and the water was used as before. It became so offensive that its use was forbidden, but too late to save the family, nine of whom died of cholera.[1]

At Farmington, Tenn., a man arrived who had contracted the cholera at Nashville; his illness ran its course at a point just forty paces from a well. Families that obtained their water from this well suffered in nearly all their members; where only certain members drank of it, they alone were affected.[2] At Huntsville, Ala., during an epidemic of cholera, the city authorities forbade the use of well-water, and supplied pure water from another source, but only for one week. During this time no new cases of the disease occurred, and the negroes, thinking themselves secure, resumed the use of the well-water, and within four days six fatal cases of cholera occurred in the vicinity. The use of the well-water was again prohibited, and again the progress of the disease was arrested.[3]

It has already been intimated that the cholera-poison may be diffused through the air from either moist or dry sources, and especially from contaminated clothing, and then be taken into the throat and swallowed. Dr.

[1] *Times and Gaz.*, April, 1884, p. 140. [2] *Ibid.*, p. 172.

[3] *Ibid.*, p. 408. For other examples of the spread of cholera by means of drinking-water see Macnamara, p. 149 and seq.

Richardson refers to a local epidemic in England in which "the persons most constantly and fatally attacked were the women who washed the clothes of the sick;" and this circumstance has been largely confirmed by other observers.[1] During the Crimean War many of the washermen attending to the washing of the French hospitals were attacked by cholera. Dr. Koch, in his *Report on the Cholera in Egypt*, speaks of the frequent infection of washerwomen who had to wash soiled linen, and he refers to a case of the kind which occurred, during the existing epidemic, in the Greek Hospital in Alexandria.[2] In the post-office at Marseilles none of the clerks who handled the outgoing mails were attacked, but of those who sorted the mails coming from the East, where the disease prevailed, one after another suffered from cholera.[3]

The cholera was introduced into Guadaloupe by clothing contained in a trunk belonging to a person who died on the voyage thither from Marseilles, where the cholera then prevailed. The woman who washed the clothing died, with all her family. Attracted by the circumstances of the case, many came to her house, and of these several died. From this point the disease spread over the island.[4] A sailor died at some port in Europe of Asiatic cholera in 1832. A chest containing his personal effects, clothing, etc. was sent home to his family, who lived in a small straggling village on the Atlantic coast of the State of Maine. It reached them about Christmas, and was opened on its arrival.

[1] *Trans. Epidem. Soc.*, ii. 429.

[2] *Times and Gaz.*, October, 1883, p. 448.

[3] Read, Boston, 1866. [4] *Med. Times and Gaz.*, April, 1874, p. 387.

The inmates of the house were all immediately and suddenly seized with a disease resembling Asiatic cholera in all its malignity, and died. There had been no cholera in the State. The last case of cholera that occurred in the garrison at Malta in the epidemic of 1865 was that of a woman who had stolen a chemise the property of one who had died of the disease. She put on this fatal garment, probably soiled with cholera discharges, and certainly unwashed, many days after the death of its former possessor; she took the disease and died.[1]

In 1884 a limited, but severe, outbreak of cholera took place at Yport, a Norman fishing-village. On the 7th of September a fishing-vessel from Newfoundland arrived at Cette, in the south of France, where cholera prevailed, and several of the crew were attacked by the disease and two died. Two of the men reached Yport on September 28th. One of them had suffered a choleraic attack at Cette, and the day after his arrival his clothes were, with the aid of his brother and his sister-in-law, wrung out in water and hung up in front of the neighboring dwellings, the slop-water being allowed to flow down the street. On the 4th of October the sister-in-law, then suffering from diarrhœa, washed out these same garments at the *fontaine*, and was seized with all the symptoms of Asiatic cholera and soon died. Another woman died on October 8th, and five others before the 22d. The total attacks were 42, of which 15 were fatal.[2]

It is sometimes said, and oftentimss repeated, that

[1] *Lancet*, Feb, 17, 1866.

[2] *Practitioner*, xxxiv. 157.

cholera is not directly contagious—is not communicated by the sick to the well. No statement could be more unfounded. The whole history of cholera proves that the physicians and nurses of cholera patients are often affected by the disease. "In Constantinople no less than twenty-seven physicians and medical assistants were attacked and died during their attendance on cholera patients; and in Paris and Toulon similar results followed. At Halifax, N. S., two of the physicians who volunteered in aid of the steamer England, which put in there disabled by the ravages of cholera among the officers and crew, as well as among the steerage passengers, took the disease, and one died" (Read). In 1832 the cases of cholera in Edinburgh were in the proportion of 1 to every 1200 of the population of the city, while among those in attendance upon the sick the proportion was 1 to 5. In 1848–49 one-fourth of the nurses employed in the cholera hospital took the disease, while in the general hospital, only a few paces distant, where no cholera patients were received, not a single attendant was attacked. In the London Hospital, in 1866, none of the medical officers, volunteer nurses, or sisters were attacked, Of the (regular) nurses five contracted the disease, and of these four died.[1] In 1849 a severe and fatal epidemic broke out in the Philadelphia Almshouse. The resident physicians of the hospital were abundantly occupied with the care of the sick of other diseases, and it was thought prudent not to allow any, even an indirect, communication between them and the cholera patients. The latter were therefore removed to an isolated build-

[1] *London Hosp. Rep.*, iii. 439.

ing in the middle of the quadrangle, and attended by physicians from the city who had volunteered their aid. Three or four of these physicians had attacks of cholera, and two of them died.[1] At this time there was no cholera at all in the city, and the young physicians could not have become infected outside of the almshouse. They were attacked while attending the sick of cholera, but the regular house-physicians, who seldom visited the cholera patients, escaped altogether.

Again, some physicians claim that cholera is not contagious because it is not conveyed by contact or by inoculation, but as typhoid fever and dysentery are transmitted.[2] Then typhus and typhoid fever, and perhaps scarlatina and measles, are not contagious! This writer admits that cholera is "infectious" through air or water, or in the same manner as dysentery; in other words, it is communicable by the sick to the well. This is an essential and unquestionable fact in the history of the disease; let those who prefer to describe it by one term rather than another please themselves in their choice.

The importance of recognizing the communicability of cholera is so great that no apology need be made for introducing the following additional illustrations of it furnished by Griesinger in his article on the dangers of cholera to medical men. They are the more important because in many other instances cholera physicians have suffered little for their devotion to duty: "At Moscow, in 1840, hospital attendants contracted the disease to the extent of 30 or 40 per cent., while in the

[1] *Philada. Med. Examiner*, Nov., 1849.

[2] Dutrieux Bey, *Le Cholera dans la basse Egypt, en 1883.*

general population only 3 per cent. were attacked; at Berlin, in 1831, in Romberg's hospital, 54 out of 115 persons were attacked: in 1837 one-fifth of the attendants took the disease, and on one occasion no less than seven of them fell ill on a single day. In La Charité Hospital in Paris, in 1849, one-sixth of the attendants had the disease, while only one-twenty-fifth of the general population of the city suffered from it; at Mittau, in 1848, one-half of the physicians took the disease; in 1842, at Toulon, ten health officers out of thirty-five were ill with cholera, and five of them died, while of thirty workmen who were employed to carry the dead bodies one-third succumbed; at Stockholm, in 1853, of 536 attendants one-eighth took the disease, and half of that number died; at Vienna, in 1854, out of thirty-six nurses, seven caught the disease, and seven men employed in removing the dead became affected with a prolonged and exhausting diarrhœa; in 1849, at Strasburg, five nurses out of ten were attacked, etc." . . . . "Physicians, nurses, students, etc. are less frequently affected, however, than patients ill with other diseases who are lying in the wards where cholera patients are treated, and who are therefore more constantly exposed to the emanations from the discharges; and physicians usually suffer less than the attendants who are constantly waiting on the cholera patients."[1]

It may be added that Surgeon-General John Murray, who served continuously for thirty-eight years in British India, caused upward of five hundred circulars to be addressed to the local governments and filled up by the local medical officers. From these returns it ap-

[1] *Traité des Maladies infectieuses*, 1868, p. 409.

peared that the belief in the communicability of cholera, in one way or another, was practically unanimous; for of the whole number, those who believed that it is conveyed from person to person were 75 per cent.; from place to place, 85 per cent.; through the atmosphere, 80 per cent.; with the drinking-water, 85 per cent.; by the evacuations, 92 per cent.; and by clothing, 98 per cent.[1] This gentleman has more recently furnished additional facts supporting the same conclusion. For example: Out of fourteen cases that occurred at Ramleh during the Egyptian epidemic, eleven occurred in patients already in the hospital for other diseases. In 1856, after visiting the dead-house where the bodies of fourteen cholera patients lay, as he entered the cholera ward he felt a sudden shock in the epigastrium, followed by a deadening sensation that rapidly spread over the whole body. On another occasion he saw a clergyman who was talking to a cholera patient suddenly seized with vomiting of a watery liquid. Several analogous instances are related by him.[2]

It has been objected to the communicability of cholera that its dissemination does not always follow the deposit of cholera discharges in privies, wells, etc., and also that when infection does take place, it may occur between remote extremes as to time, and therefore cannot be attributed to infectious germs. Such objections are frivolous, because we know nothing of the nature or vitality of cholera-germs, and they are, moreover, drawn from exceptional cases. The power

[1] *Practitioner*, xix. 470.

[2] *Med. Times and Gaz.*, March, 1884, p. 281.

of infected fomites to develop the disease has been preserved, in a journey from Arabia into Africa, for at least twelve days, and for even a longer period in passing from Germany to Chicago, as already related. It is true of every infectious and contagious disease that it may possess one or both of these qualities in various degrees—that at one time it is only exceptionally communicated, and that at another time it appears to propagate itself virulently. So the phenomena of cholera may consist of little more than a watery diarrhœa, which may be so mild as hardly to disable the patient from working, while at other times the attack may include all those terrible and fatal symptoms which have won for the disease the name of malignant. That a certain quantity, or "dose," of the cholera-poison is required to develop the disease, but one that varies considerably in different cases, may be inferred from these facts: 1. Out of a certain number of persons equally exposed to receive the disease, only a portion may be attacked at all, and these in very unequal degrees. 2. Persons so slightly affected as to be ignorant of the nature of their sickness, and believing it to be an ordinary diarrhœa, may nevertheless become the innocent, because ignorant, disseminators of cholera. The explanation of such facts may be manifold: they may depend upon the dose or upon the energy of the morbid poison, on various possible conditions of its recipient, and so on; but, however explained, their reality is none the less certain. The receptivity of persons exposed to the contagion of cholera is very different. It is well known that some persons appear to be proof against other contagious

diseases, while others seem never to acquire an immunity from them. On this very important point the conclusions of Fauvel directly bear.[1] They include the following propositions: The East Indian ports where cholera exists as an endemic disease are never the seat of an extensive epidemic among the native population. But strangers to these localities are liable to the disease, and such are the Mussulman pilgrims who come to Bombay to take ship for Mecca. A severe epidemic of cholera confers upon the locality in which it has taken place an immunity which in India appears to be of several years' duration. Such an epidemic in any country is a proof that the cholera is not endemic there.

If a contagious disease preserved its virulence undiminished, it might continue to prevail indefinitely. But we know that all other contagious epidemics do come to an end sooner or later, and hence we must conclude that their specific cause progressively loses its virulent qualities. There is every reason, therefore, to believe that the same is true of cholera. Its communicability, and therefore its diffusion, may vary with climatic, seasonal, local, personal, and other conditions; but of what nature those conditions are, and especially of the last and most important, the personal, hardly anything is known. Nor need we too curiously investigate them, so long as the fact remains that outside of, and independent of them all, there is but one essential cause of cholera—a morbid poison as specific in its nature as that of any of the eruptive fevers—a poison which no determinable conjunction of circum-

[1] *Mémoire lu à l'Académie des Sciences*, 1883.

stances has ever engendered, and which was unknown in Europe and America before it was carried to them from India. In just such a way did small-pox first arise in the Western World. It had never appeared in Europe until the latter part of the sixth century, when for a short time it prevailed in Marseilles and the neighboring country. Afterward it was not heard of until it was reintroduced by the Crusaders on their return from Palestine in the twelfth century, since which period it has hardly ever ceased. The history of the diffusion of cholera is closely analogous to this in several particulars, and we may reasonably expect that what was in the last generation a new disease will henceforth be liable to prevail again and again as the intercourse increases between the nations of the West and the immemorial source of cholera in Hindostan.[1]

In the preceding discussion of the origin and dissemination of cholera the broad facts of its specific nature and its contagion by means of excreta have been chiefly insisted upon. Little has been said either of the nature of the contagium or of the conditions that modify its activity. These points will be considered hereafter. But it is proper in this place to state that, in the opinion of most investigators, the contagious element has the power of multiplying itself, not only within the body, but wherever it is in contact with decomposing organic matter, provided that the degree of heat and amount of moisture present are adapted to promote such a change, which is certainly analogous to fermentation, if not identical with it. And

[1] Additional illustrations of the communicability of cholera are contained in the *Brit. and For. Med. Chir. Rev.*, July, 1872, p. 56.

the facts already mentioned may be recalled, which show that the contagium cannot be a light and subtle substance, since, as has been stated, the immediate attendants upon cholera patients are not as apt as might be expected, on that hypothesis, to contract the disease, while washerwomen inhaling, and probably swallowing, the moist fumes from cholera fomites much more frequently do so; that fomites saturated with the dried discharges are very infectious; and that water is the principal vehicle by which cholera-germs are carried into the stomach.

SYMPTOMATOLOGY.

Like other diseases, cholera occurs under very dissimilar aspects and with various degrees of gravity. Like those especially which are caused by specific morbid poisons, it may be so insignificant as to escape recognition, or, on the other hand, it may give rise to violent and distressing symptoms which come on without warning and hurry the patient to inevitable death. Whenever epidemic diseases present such opposite extremes of severity in their symptoms, it may reasonably be inferred that the differences depend mainly upon the quantity of the poison that has been received into the system, precisely as the dose which has been taken of a narcotic or acrid poison may be estimated by the gravity of its effects. Individual peculiarities, constitutional or acquired, may modify the characteristic phenomena, and sometimes a careful inquiry may be necessary even to detect their existence; but a

study of cholera in all its grades shows that its symptoms are all the effects of one and the same cause, and that the cholera-poison acts primarily upon the gastro-intestinal mucous membrane. It follows, as a matter of course, that, being thus applied, it will occasion symptoms differing in degree and in kind according to the energy of its action, and that this, again, will depend partly upon the inherent virulence of the agent and partly upon its quantity. In fact, this feature in the clinical history of the disease can be explained only by the operation of a special irritant acting with different degrees of power upon the gastro-intestinal mucous membrane. In other words, the different forms under which it is convenient clinically to recognize and describe cholera are nothing more than differ ent degrees of the operation of one and the same poison modified more or less by the peculiarities of individual patients. In the most typical of the fully-formed cases of cholera there is a stage of diarrhœa, a stage of cholera morbus—*i. e.* of vomiting and purging—with more or less evidence of stagnation of the blood, which is followed either by reaction and recovery or collapse and death. The phenomena of those several stages will now be described, after which certain symptoms will be more particularly considered.

It has more than once been pointed out that, however mild an attack of cholera may be, the dejections accompanying it are infectious, and may produce in other persons the gravest types of the disease. Hence the importance, not only to the patients, but also to others, of recognizing it in the earliest stage; for while this knowledge may suggest measures for preventing

an extension of the disease, it leads to the prompt use of remedies at the only period in which their success can at all be counted upon. The characteristic of this stage, which has generally been called either choleraic diarrhœa or cholerine, is a diarrhœa remarkable for its profuseness and the frequency and serous quality of the stools, which are, however, of a more or less yellow color. They are preceded by rumbling and gurgling noises in the abdomen, are voided without colic or tenesmus, and are followed by a remarkable sense of exhaustion or faintness, which is sometimes also accompanied with nausea, and if they are very frequent and copious, cramps are apt to be felt in the calves of the legs. In this variety or stage of the attack, as a rule, there is not any vomiting; there is complete anorexia, but urgent thirst, a white and clammy tongue, and a peculiar alteration of tone, a huskiness, faintness, or hoarseness of the voice. The stools vary from six to twelve a day, and, as above stated, are slightly yellow; they are also alkaline, and on standing deposit a granular sediment which consists largely of the débris of intestinal epithelium. Unless the attack is very severe the temperature is not lowered by much more than 1° F. The symptoms now described, especially in their milder grades, may last for a week or even longer, and then, according to circumstances, end either in cure or in fully-developed cholera; but under appropriate treatment they usually subside in a day or two, and more or less rapidly according to the degree of damage done to the digestive mucous membrane.

Between the above, which is the mildest type of epidemic cholera, and the fully-developed disease must

be placed that grade of the disease which is more appropriately called cholerine, comprising cases in which vomiting occurs as well as purging, with increased debility and a tendency, more or less decided, to collapse. The matters vomited, after the rejection of undigested food, are at first bilious, but they gradually become less and less so the longer the attack lasts, and, together with the stools, assume the appearance of rice-water—*i. e.* they consist of a pale grayish, semi-transparent liquid in which white flocculi are suspended. Its reaction is alkaline, and it has a faint albuminous or spermatic smell. Along with these symptoms the other effects of serous depletion arise—debility with pallor, duskiness, coldness, profuse perspiration, and a sodden condition of the skin, while the secretion of urine is diminished, and all the symptoms that belong to the first stage of cholera are present in an aggravated degree.

A curious feature of this disease is that sometimes the onset even of its graver forms is not attended by any evacuations, although the stomach and intestine may be filled with liquid. It is perhaps chiefly in such cases that the patient experiences a rapid depression of all the mental and physical faculties. The senses are irritable, the head aches and is confused, there is a disinclination to sleep, the limbs totter under the weight of the body, the pulse is frequent and feeble, occasionally fainting takes place; the skin is cool and bedewed with perspiration. In other cases, again, the attack is sudden; the patient is smitten with an unaccountable feebleness, speedily followed by profuse vomiting and purging and general spasms, and dies with-

out any suspension of the symptoms or any tendency to reaction.

But more usually the attack begins with the diarrhœa and vomiting described above, which then assume, more or less rapidly, a high degree of violence, expressed by their frequency and excess. The stools with proportionate rapidity lose all their fecal qualities and acquire the rice-water appearance before mentioned, and the liquid rejected by vomiting in all respects resembles them. It is poured forth less by an ordinary act of vomiting than by gushes, as if it overflowed from the throat and mouth; and it often escapes from the stomach and the bowels at the same instant. Such profuse evacuations necessarily occasion an urgent thirst which cannot be satisfied, for liquids are thrown up immediately on being swallowed. Sometimes a distressing hiccough accompanies these symptoms. It is indeed only one of the many spasms which may affect the muscular system. They generally begin in the fingers and toes, which become bent and stiff; they seize upon the muscles of the calves of the legs, and render the muscular wall of the abdomen as hard as a board. The pain they produce is extremely severe, and unless the patient is exceedingly prostrated he endeavors to assuage it by a constant change of position.

At this period the debility is very great, and progressively increases, and the patient is unable to rise, or even to move at all except under the stimulus of the painful spasms. The features are shrunken; the nose is sharp and pallid, and bent to one side; the dusky, lack-lustre, and sunken eyes, the thin lips, the

hollow cheeks, and the contracted muscles that stand out like cords under the tense and clammy skin, present a physiognomy that belongs to no other disease in the same degree. The hands and feet grow cold, and steadily the coldness creeps upward toward the trunk; the temperature falls to 94° or 95° F.; the feeble and even flickering pulse ranges from 100 to 120. The integuments of the limbs are shrivelled and damp, and look as if they had been macerated in water; and if a fold of the skin is pinched up, it subsides very slowly indeed. The eyes grow dull and dry, the tongue has a pasty or sticky feel, and the urine is almost suppressed. If any of this excretion can be obtained for examination, it is found to contain both albumen and sugar. As the attack advances the patient falls into a dull, listless, and motionless state, which may be mistaken for insensibility or even unconsciousness, but is really due to exhaustion of all the faculties of mind and body. He may express no interest in anything, and hardly notice the attention or the distress of his friends, yet he will generally give clear, although languid, answers to questions, and fall again into an inert and unobservant state.

As these symptoms continue and the fluids of the body decrease, the blood accumulates and stagnates in the veins, giving to the hands and feet, the nose and lips and other features, to the neck, and even to the entire surface of the body, a bluish, leaden, or violet tint, precisely like that of cyanotic children. The pulse, that was already weak and thready, is no longer perceptible; the carotids even and the impulse of the heart cease to be felt, and the second sound of the

latter becomes inaudible. The skin is everywhere cold; the hands, feet, and face are sometimes of an icy coldness, and yet the patients seldom perceive that they are so; indeed, complaint is more apt to be made of suffering from internal heat. Even the breath as it issues from the nostrils feels cold. The blood no longer circulates, and the heart seems still. If a vein is opened a few drops of black and viscid blood will trickle from the wound, which if it coagulates, yields but little serum, and in place of a firm clot only a diffluent jelly. The voice has sunk to a mere whisper or is quite extinct. The features assume a distorted and frightful expression; the temples and cheeks are hollowed; the nose is twisted and pointed, and the nostrils are obstructed with dry and powdery crusts; the eyes are also dry, dull, and sunken behind the half-closed and purple lids; the conjunctiva is no longer moistened by its secretion and becomes bloodshot; the temperature in the mouth may fall to 79° or 80° F.; a viscid exhalation bedews the icy and marbled skin; and the whole body is so shrunken from its natural proportions as to lose all the marks by which its identity has been recognized. From this pulseless, exhausted, cold, and cyanotic condition there can be but one step to death. It generally comes on gradually, the patient sinking into the state of apparent insensibility before mentioned; on the other hand, he may expire suddenly on attempting to make some unusual effort.

At any period in the progress of cholera, except that of complete asphyxia, the contest between the system and the disease may be decided in favor of the former.

If this occurs before profuse evacuations have taken place or blueness of the skin appeared, the recovery may be gradual and present no special phenomena. The pulse regains by degrees its natural force; the skin grows warm again, first upon the trunk and afterward upon the extremities; the breathing becomes easy, and, the diarrhœa having already ceased, convalescence is established. But in proportion to the severity of the symptoms, the intensity and duration of the cold stage, the cramps, and the evacuations, will there be a tendency to febrile reaction, with more or less passive congestion of the internal organs, and therefore a slower return to health. If the attack has been very severe, and particularly if the algid stage has been prolonged, fever of a low type is apt to occur, and indeed may terminate fatally. This fever presents all the characters of the typhoid state, and is marked by dryness of the tongue, a brown crust upon the teeth and gums, jerking of the tendons, delirium, and coma. These symptoms are partly evidences of exhaustion, of inability of the system to resume its normal action, and perhaps also they denote the retention of the effete products of nutrition in the blood; but sometimes they appear to be associated with, and caused by, a local and latent inflammation of low grade, established usually in the lungs. Again, the nervous system seems to bear the brunt of the reactionary effort, and the patient is attacked by convulsions or perishes in an apoplectic fit. These phenomena appear to be due in most instances, if not in all, to renal obstruction, and, as it is supposed that their immediate cause is the retention of urea in the

blood, they have received the title of uræmic. In other cases a wasting diarrhœa, due probably to the damaged state of the intestinal mucous membrane, is superadded to the already existing typhoid state. Occasionally the parotid glands become enlarged and painful, and sometimes a measly or roseolous eruption appears upon the skin.

It frequently happens that the convalescence from cholera is slow and irregular. The system seems to be shattered by the trial it has passed through; the nervous susceptibility is for a long time morbidly increased, or, what is still more usual, the digestive function is greatly impaired. The appetite is capricious and the digestion feeble. The mouth is pasty, the abdomen tympanitic, the bowels are irregular and alternately confined and relaxed. Finally, patients who leave the bed too soon or indulge prematurely in their ordinary diet are liable to a relapse, perhaps fatally, into the original disease. It has sometimes happened that such a relapse has taken place several days after an apparent restoration to perfect health.

COMPLICATIONS AND SEQUELÆ.

In a small proportion of cases, as above stated, cutaneous eruptions have been observed during the attack of cholera, or rather during its decline, for they coincide with the reaction or follow it, and may be regarded as indications of increasing vitality. They belong to the exanthematous class, and comprise roseola, ery-

thema, urticaria, and rarely vesicular eruptions.[1] But, instead of them, there may occur destructive tissue-lesions in the form of abscesses or ulcers. These affections are more usual on the limbs than on the trunk or face, but some of them may appear even in the mouth or fauces. Profuse sweats have been noticed elsewhere, and the important fact that they carry off large quantities of urea, which they deposit upon the skin. Diphtherial exudation has also been met with upon tender parts of the skin and in the fauces, as well as in the stomach and intestine. In some epidemics of cholera suppuration of the parotid gland is occasionally observed, while in others it may be entirely absent. Instances have been reported of double parotitis, and in several of them the termination of the attack was fatal. Still more rarely suppuration of the submaxillary or the cervical glands has been met with. Another sequela of cholera is a tetanic contraction of the flexor muscles of the limbs. Between the tenth and fifteenth days of convalescence the patient is attacked with a tearing, rending pain in the hands and forearms, the legs and feet, followed by tonic contraction of the flexor muscles of these parts. The sensibility is not impaired. The attack lasts for one or several days, and seems always to end in recovery (Guterbock).

Some of the individual symptoms of cholera call for a more detailed notice than they have received in the foregoing epitome, in which the continuity of the narrative could not be interrupted by a description of

[1] Compare *London Hosp. Reports*, iii. 457.

variations depending upon the stage and grade of the disease.

The first to be considered is the temperature. The animal temperature in cholera varies according to the part of the body at which it is taken more than in any other disease. In cases of average severity it rarely falls below 95° F. in the axilla. The temperature under the tongue does not furnish trustworthy indications. In the stage of asphyxia it seldom exceeds 87.8° F., and even in cases that recover it may fall to about 78.8° F. (Wunderlich). In the cold stage it is not uncommon for a difference of temperature to be noted of nearly ten degrees between the axilla and the rectum. In a female aged thirty-two the temperature in the axilla was 93° F., and that in the vagina 102.8° F. (Mackenzie). In other cases a vaginal temperature of 104° F., and even of 108.32° F., has been reached (Guterbock). Such high temperatures furnish an unfavorable prognosis. As Wunderlich has pointed out, during the algid stage temperatures taken in the mouth do not give an accurate idea of the general temperature; the rectal and vaginal temperatures are more nearly correct. The following are some results of thermometry in 74 cases of cholera: Lorain found the minimum rectal temperature in 1 case 93.2° F., in 2 cases 95°, and in 10 cases 96.8°. In 47 cases the normal temperature was preserved; in 27 it rose to 100.4°; in 15 cases to 102.2°; and in 1 to 104° F. Leubuscher gives the average temperature in the armpit 92.7° F.; under the tongue, 90.5°; upon the tongue, 81.5°, in the nostrils, 79.2°; and on the palm of the hand, 84° F. These numbers, however, only

represent averages. It should be noted that the low temperature of the mouth and nostrils is caused not only by the evaporation from the surface of those cavities, but also by the relative coldness of the expired air, due to the partial suspension of the passage of blood through the lungs, and therefore to the heating of the air contained in them. According to Leubuscher also, the lowest temperature is found in the nostrils, and next under the tongue, and at the latter point it may vary from 79° F. to 90.5° F. In death by asphyxia the vaginal and rectal temperatures may rise to 104°–108° F. The axillary fluctuates less than the internal temperature. It is remarkable that during the algid stage the patients, at least before the temperature has reached its minimum, are not conscious of their coldness, but, on the contrary, complain of internal heat, precisely as happens in the congestive forms of periodical fever. When the febrile reaction assumes a typhoid type the temperature in many cases is normal or only slightly elevated, and it is of serious import if the temperature then sinks again below the normal grade (Wunderlich). On the whole, the maintenance of a uniform temperature, neither much above or below 90° F. in the axilla or under the tongue, may be regarded as favorable, yet recoveries have taken place even when the temperature at these points has fallen to 79° F. If the temperature of the parts just mentioned should rise rapidly to 104° F., it may be regarded as a very unfavorable sign.

The skin, as has elsewhere been described, is pallid, bluish, shrunken, and cold, and quite destitute of its natural firmness and elasticity, so that when it is

pinched into folds they subside very slowly, as if they had been made on the skin of a corpse. It is curious that, although the drain of liquids through the bowels is so great, the skin not only remains moist, but generally is bathed in a profuse cold sweat. Although the secretion of urine is reduced or quite suspended, that of milk is said to be not always so. Large quantities of urea have been found in the urine, and in some cases it has been visible upon the skin in the form of white scales. During convalescence the skin may be the seat of the various eruptions already enumerated. Of a graver nature, but, fortunately, of rarer occurrence, are erysipelas, boils, abscesses, ulcers, and gangrene. These several affections seem to result from the alternate obstruction and freedom of the cutaneous circulation. They commonly appear first upon the limbs, and afterward upon the face or trunk; they may affect even the cavity of the mouth. Some observers have noted a relatively frequent occurrence of diphtherial exudations in this disease, while others do not allude to their existence. The former describe the false membrane as affecting not only the mouth and fauces, but also the stomach, the intestine, and the female organs of generation. A case is reported by Joseph of a young man who, after an attack of cholera, was affected with a blenorrhœa, due to a diphtherial inflammation of the urethra.

The character of the heart- and pulse-beats in this disease is quite peculiar. Their rate does not increase indefinitely, as it does after hemorrhage; the pulse usually varies from 90 to 110, and indeed seldom exceeds 120, but its volume, tension, and force pro-

gressively decline until the beats become imperceptible at the wrist, and even in the brachial and femoral arteries. At the same time, the rhythm of the heart is interrupted, the energy of its impulse declines until it can no longer be felt, and its sounds grow weaker and weaker until they become quite inaudible. Sometimes, it is said, a pericardial friction sound may be heard, which is attributed to the dryness of the pericardium. That the decline and suspension of the heart's sounds and impulse are due not only to the weakness of the cardiac muscle, but also to the lessened volume of the circulating blood, is proved by the fact that they persist, sometimes for many hours, after reaction has commenced, and only become audible again when the arteries have been replenished with blood.

In the description of the symptoms of cholera it has been mentioned that the cyanotic color of the skin is produced by an accumulation of blood in the veins. Many years ago Magendie, and after him Dieffenbach, on examining the arteries of persons in the advanced stage of cholera, found those vessels empty of blood. It might be supposed that, under the circumstances, not only the right side of the heart, but also the lungs, would be gorged with blood, and that extreme dyspnœa would result. But, in point of fact, the respiration in cholera is hurried and shallow rather than oppressed and labored, while after death the lungs are not engorged with blood, but rather in a bloodless condition. The pulmonary artery and its branches are also empty, although the right side of the heart may be filled with dark and soft coagula. These singular conditions

seem to be due, on the one hand, to the greatly diminished mass of the blood in the vessels, and to its accumulating and stagnating in various parts of the venous system, and, on the other hand, to the weakness of the heart, which is shown by its suppressed impulse and sounds, and which lessens its power to propel the venous blood into the lungs. The infarction of the systemic veins and the threatening suspension of the circulation necessarily impair the activity of all the functions, including those of nutrition and disintegration, so that the effete detritus of the economy tends to accumulate in the blood. This tendency is doubtless counterbalanced not only by the diarrhœa, but also, more or less, by the almost total suspension of nutrition, due to the inability of the cholera patient to digest or even to retain food, as well as by the diminished oxidation of the blood in the lungs. It has already been observed that, to a certain extent, the impediment to the passage of the blood from the right side of the heart into the ramifications of the pulmonary artery tends to prevent congestion and infarction of the lungs. But this obstruction is precisely what occurs during the stage of reaction in many cases, which then terminate fatally by asphyxia, as in the previous stage still more perish by apnœa.

In the milder attacks of cholera vomiting may not occur, and in the most severe it not unusually is suspended for some time before death, although the diarrhœa may continue. In the most malignant cases, indeed, there may be no vomiting at all, in consequence of the extreme muscular exhaustion, although the stomach may be distended with liquid. When

rejected, the liquid has the general aspect of rice-water, which the stools also present. Its reaction is alkaline or neutral, and it is said to contain a less proportion than the stools of solid matter, but a larger proportion of urea. The act of vomiting is strictly one of regurgitation, which is performed without effort or pain. Sometimes, indeed, it seems to relieve the sense of weight caused by the accumulated contents of the stomach. It is readily excited by attempts to drink, and even by slight changes of posture. The vomited liquid at first contains the various articles of food the patient may have eaten. Their half-digested remains have sometimes suggested the announcement of strange specific forms of cholera-germs. The liquid, after ceasing to be colored brownish or greenish, becomes gray, and subsequently, in favorable cases, more or less green again; while during the stage of reaction in grave and ultimately fatal cases it is more or less reddened by an admixture of blood. Its most usual and characteristic appearance is that of a grayish liquid containing whitish flocculi. The nature of this liquid, whether discharged by vomiting or by purging, has been variously estimated. Formerly, some persons held the white granules to be leucocytes, but the greater number agree that they are merely epithelial fragments. When the vomited liquid is allowed to stand, a sediment forms in it which is composed almost entirely of epithelial scales, more or less modified in their appearance by the accidental contents of the stomach, and a film covers its surface in which globules of fat and phosphatic crystals may be detected. They are frequently associated with sarcinæ, produced by fer-

mentation in the contents of the stomach, and after standing for some time the liquid becomes crowded with vibrios (Lindsay).

Although the propensity of the sick to discover a cause for every symptom often leads cholera patients to attribute their diarrhœa to some particular exposure to cold, error of diet, etc., yet, in fact, this symptom, so far as it belongs to cholera, is primarily an effect of the cholera-poison alone, although it may be aggravated by causes like those mentioned. It is of great practical importance to bear in mind that a specific choleraic diarrhœa —that is to say, a diarrhœa produced by the cholera-poison alone—may continue to be very slight as long as it lasts, which may be for several weeks; and hence, as elsewhere insisted upon, a person who is not suspected of being affected with cholera may, quite ignorantly, sow the seeds of a deadly epidemic of the disease. The danger in cholera is proportioned to the volume of the discharges rather than to their frequency, just as a single profuse hemorrhage is more serious than the loss of an equal amount of blood divided among several successive days. The special danger, however, is not, as in hemorrhage, from syncope, but from the progressive loss by drainage of the water of the blood, rendering it unfit to circulate, and therefore causing it to stagnate in the veins. The spoliative operation of the diarrhœa has occasionally been productive of benefit instead of injury, as in the following case of Barlow: A man suffering from dropsy was attacked with cholera, "and passed gallons of liquid by stool, had cramps, and became livid and clammy, but his pulse did not disappear, as in

profound collapse, and he eventually rallied, and left the hospital apparently well. When he began to recover from cholera his appearance was almost ludicrous, from the manner in which the integument hung loosely about him."

The stools pass through a series of changes corresponding to those of the matters vomited, being fecal at first and then becoming colorless and watery. During reaction, if that occurs, they regain more or less of their proper color, but if typhoid febrile symptoms prevail they are usually bloody. Decomposed blood sometimes renders them dark, tarry, and fetid; this condition has caused them sometimes to be described as being composed of vitiated bile, which is, however, a product not of the liver, but of the imagination.

In the intestine after death considerable quantities of epithelium are found floating in the contained liquid or else loosely adherent to the mucous membrane. It is usually in flocculi, but sometimes in fragments large enough to form a continuous membrane. A microscopic examination of cholera stools shows that their turbidness depends chiefly upon desquamated epithelium, with which are mixed white corpuscles and bacteria. It is remarkable that although the stools are drained directly and so rapidly from the blood-vessels, they nevertheless contain but little albumen, indeed hardly more than a trace of it. If, however, blood is mixed with the stools, as happens in rare instances, more albumen is present. Oil-globules are most abundant in cases that have passed beyond the stage of collapse into that of reaction with fever. In these it is said that oily matter may be found either in concrete

masses or as a scum of liquid oil. Of inorganic constituents they contain crystals of the triple phosphate of ammonium and magnesium and chloride of sodium in greatest abundance, but the proportion of ammonium and potassium salts is small. Indeed, the total amount of solids does not exceed 2 per cent. As the quantity of water in the blood and solids is limited, and as in this disease the stomach will not receive nor retain any liquid, it follows that the more profuse the evacuations are, the shorter must be the duration of the attack, for the sooner then does the blood become too thick to circulate.

It has several times been stated that in cholera the urine is diminished, and that, therefore, the blood retains a larger proportion of effete products than in health. But it has also been remarked that the amount of these products is abnormally small, on account of the interference with nutrition of the abnormal state of the circulation. Doubtless, as in other cases of renal obstruction, an increased proportion of effete matter is eliminated by the skin, if not by the bowels. When the amount of urine excreted is only diminished, its specific gravity may vary between remote extremes, as 1.012 and 1.030. Usually, however, when its quantity is very greatly reduced, symptoms which are described as uræmic are apt to arise, and the urine is found to contain the usual products of renal congestion—viz. albumen, sometimes traces of blood, hyaline and granular casts, and epithelial scales, with less chloride of sodium and more urea than normal. It is remarkable that at the beginning of convalescence the urine, which had been suppressed or greatly diminished, may be-

come for a time abnormally abundant. Rarely, if ever, does the derangement of the kidneys now described denote or produce an organic lesion in those organs. Like the disorders elsewhere, these are due to the loss of balance between the arterial and the venous sides of the circulation; both, indeed, have lost their functions more or less, the one by lack of blood, the other by an excess of blood unfit for circulation.

The occurrence of cramps in cholera, which has bestowed upon the disease one of its titles, spasmodic, has, however, no distinctive relation to the Asiatic disease. Spasmodic phenomena occur in many cases of poisoning by corrosive and irritant agents and in ordinary cholera morbus, and in cholera infantum they are among the most alarming symptoms, assuming, as they often do, the character of general convulsions. In most of these cases they are clonic and general, and therefore probably of central origin, primary or reflected; but the spasms of cholera are tonic, and affect the muscles of the upper and lower limbs, and most frequently the flexor muscles of these parts, and especially those of the fingers and toes, which become rigidly bent. The larger muscles contract into hard lumps, and even those of the chest and abdomen do not escape the terrible spasms. When they are severe they extort cries from patients who at other times seem quite apathetic. It is stated by Macnamara that the natives of Southern Bengal and other people of relatively loose fibre are much less apt to be attacked by them than the natives of the upper country or than Europeans. It may be debated whether their immediate cause is a reflex irritation emanating from the gastro-intestinal mucous mem-

brane; or whether it is due to the rapid diminution of the supply of blood to the nervous centres, or to the infarction of those centres with thick and imperfectly oxygenated blood; or, finally, whether it is occasioned by a diminished supply of blood, and that blood of bad quality, to the muscles themselves. Probably all of these factors are associated causes in producing the spasmodic phenomena of cholera. It is well worthy of notice, however, that spasms, which are so frequent in all infantile diseases, and especially in those affecting the stomach and bowels, rarely attack children suffering from cholera. This would seem to prove that the spasms in question are not reflex, but either central and spinal, or else muscular—an inference which is strengthened by their being tonic and not clonic. As stated, the spasms, or cramps, frequently affect the limbs, but comparatively seldom involve the muscles of the chest or abdomen, and those of the face hardly ever. They are almost the only causes of pain in the disease, which in not a few instances runs its whole course, even to a fatal termination, without their occurrence.

As a rule, the abdomen is not so much retracted as might be expected from the profuse discharges. Probably in some degree its form is maintained by the constantly recurring accumulation of liquid in the gastro-intestinal cavity. In protracted cases, however, the abdomen becomes sunken and hollowed. At all stages of the disease it is somewhat sore under pressure, especially at the epigastrium, and it generally has a doughy feel. As to the functions of the digestive organs, they are completely suspended during a typical attack of the

disease. Not only are these organs incompetent to digest food, but they cannot even retain it.

Throughout such an attack not only is sleep apt to be prevented by the pain of the cramps and the frequent evacuations, but, as a rule, the patient is wakeful, and yet, apart from the restlessness which accompanies the paroxysms of pain, there is, on the whole, a tendency to a placid quietness. Mental excitement and delirium are probably unknown during the primary attack, but sometimes a degree of somnolence or of apathetic tranquillity exists, which, however, is quite distinct from coma. When the attack is prolonged, and especially when it merges into a typhoid state, the eyes become inflamed by their exposure to the air. The conjunctiva then grows blood-shot, and occasionally the cornea is ulcerated.

MORBID ANATOMY AND PATHOLOGY.

The appearance after death of a person who has died in the collapse of cholera is very characteristic. It comprises a shrunken aspect of the whole body, its prevalent grayish or leaden pallor contrasting with the livid hue of the abdomen and back, the fingers and toes, the lips and eyelids, and ears; the eyes are sunken deeply in their orbits; the nose is sharp and bent, the temples are hollow, and the skin seems to cling tightly to the bones beneath it. The connective tissue is very dry, and the muscles are hard as well as dry, and, owing to the wasting of the softer parts, stand prominently out. In consequence of the absence of

moisture decomposition takes place very slowly. Cadaveric rigidity is very marked and persistent. A very notable phenomenon is the occurrence of muscular contraction after death. It may be excited mechanically or may occur spontaneously. A case is related (Eichhorst) in which three hours after death the fibres of the biceps were observed to move tremulously, and then the entire muscle contracted, causing flexion of the forearm. Even the fingers performed movements like those made in piano-playing. The lower jaw has also been observed to move, causing the mouth to open and shut repeatedly. The late Sir Thomas Watson long ago described this singular phenomenon as follows: "A quarter or half an hour, or even longer, after the breathing had ceased, and all other signs of animation had departed, slight, tremulous, spasmodic twitchings and quiverings and vermicular motions of the muscles would take place, and even distinct movements of the limbs, in consequence of these spasms."[1] It was carefully studied by Barlow, from whose narrative the following is taken: The patient was a strong man; the course of his attack was rapid, and he suffered most cruelly from cramps. "Within two minutes of his ceasing to breathe muscular contractions began, becoming more and more numerous. The lower extremities were first affected. Not only were the sartorius, rectus, vasti, and other muscles thrown into violent spasmodic movements, but the limbs were rotated forcibly and the toes were frequently bent. The motions ceased and returned; they varied also: now one muscle moved, now many. Quite as remarkable were

[1] *Lectures*, Am. ed. of 1872.

the movements of the arm: the deltoid and biceps muscles were peculiarly influenced; occasionally the forearm was flexed upon the arm—flexed completely, and when I straightened it, which I did several times, its position was recovered instantly. The fingers and thumbs were now and then contracted, and at times the thumbs were separately moved. The fibres of the pectoral muscles were often in full action; distinct bundles of them were seen at intervals beneath the skin. . . . . After I had taken leave of the body the nurse was horrified by a movement of the lower jaw, which was followed by others; and I thought for a moment that the man was alive. The facial muscles became generally affected, and at length all was still."[1] These muscular contractions succeed one another in a regular order, beginning in one lower extremity and extending to the other, then to the upper limbs, and finally to the face. Their degree varies from a slight quivering to a powerful contraction, and their duration from a minute or less to an hour and a quarter. Cases have occurred in which the legs were so forcibly retracted that they could with difficulty be straightened again. In one case, six hours after death movements took place in one leg, and the hand was drawn across the chest; in another, "the forearms were powerfully flexed, and the hands, approximating, gave the attitude of praying to the body."[2] Again, Mr. Ward reports: "I saw the eyes of my dead patient open and move slowly in a downward direction. This was followed, a minute or two subsequently, by the movement of the

[1] *London Med. Gaz.*, Nov., 1849, p. 798.
[2] *Ibid*, Jan., 1850, p. 185.

right arm (previously lying by the side) across the chest." In the same paper Barlow says: "Mr. Lawrence mentioned to me that a gentleman who died in 1832 of rapid cholera was turned after death completely on the side by a strange and forcible combination of muscular contractions."[1] These muscular phenomena after death form an interesting feature in the history of cholera, but they are by no means peculiar to that disease. They have been observed in other diseases, and especially in yellow fever—an affection in which the pathological condition is quite unlike that of cholera. In both cases they have been manifested in robust persons and when the course of the fatal attack was both rapid and severe. Thus, Dr. Dowler of New Orleans not only found that they could be developed in such cases of yellow fever by striking the muscles, but he observed their spontaneous occurrence in several, of which the following is a remarkable example: "Not long after the cessation of the respiration the left hand was carried by a regular motion to the throat, and then to the crown of the head; the right arm followed the same route on the right side; the left arm was then carried back to the throat, and thence to the breast, reversing all its original motions, and finally the right hand and arm did exactly the same."[2] In 1860, Drasche alleged that not unusually the skin covering the contracting muscles became reddish, while the local temperature rose ½°, and that as soon as the contractions ceased the temperature fell below the normal and cadaveric rigidity set in. According to the same ob-

[1] *London Med. Gaz.*, Jan., 1850, pp. 185, 186.

[2] *Experimental Researches*, 1846.

server, analogous contractions affect the unstriped muscular fibres, in those of the skin producing a projection of the papillæ, and in the genital organs a discharge of semen. This phenomenon is said to have occurred an hour and a half after death.

On opening the abdominal cavity of persons who have died in the collapse of cholera one is struck by the general pink or rose tint of the peritoneal coat of the intestines. It is produced by a repletion of the minute branches of the portal venous system. Sometimes the color is rendered very dark by the pitchy blood contained in the veins. The surface of the peritoneum, like all the tissues, is singularly dry, and often has a soapy or sticky feel, caused by a layer of albuminous matter, which forms a lather when rubbed between the fingers and causes the intestinal folds to adhere to one another. If death takes place during the stage of reaction, these appearances are less distinct, and the intestines, which in collapse are usually retracted, are then somewhat distended.

The stomach generally contains a thin, partially transparent liquid of a greenish or grayish color, and occasionally reddish, holding in suspension portions of coagulated mucus and an unctuous substance of an albuminous nature, which adheres to the walls of the cavity. Fatty globules may be observed floating in the liquid, which under the microscope reveals epithelial débris, granular corpuscles, and fragments of gastric glands. Under heat and nitric acid coagulation of the liquid occurs, and on chemical examination it is found to contain urea. The gastric mucous membrane is of a dark-violet or pale-pink color, according to the

stage of the disease; its follicles are enlarged, and patches of superficial abrasion may be observed on it.

The intestinal canal of those who die during the collapse of cholera is, in the majority of cases, partially filled with liquid which has the aspect of turbid serum, more or less mixed with the previous contents of the bowel if death has taken place very rapidly, but otherwise it is almost colorless. On the whole, however, it is less pale and watery than the stools. It contains, like these discharges, more or less epithelial flocculi, and generally more than were observed during life in the dejections. The mucus scraped from the lining membrane of the intestine and mixed with water renders it turbid with epithelial débris. The same mucus examined microscopically contains fragments, larger or smaller, of epithelium. These conditions are said to predominate in the large intestine. Indeed, the proportion of liquid increases from above downward. Hence in the more prolonged cases the contents of the bowel at its upper part are less liquid and are darker in color. There is, indeed, a striking contrast between the appearance of the intestine in cases which have terminated in collapse and its aspect in persons who have died during the stage of reaction. It has been clearly presented by Dr. Sutton.[1] When death took place in "the cold stage the mucous membrane was unusually pale in three cases; in two it was healthy-looking; in other two it was pale throughout, excepting that one or two of Peyer's patches were congested; and in the remaining three there was more or less congestion of the mucous membrane. When

[1] *London Hosp. Clin. Lect. and Reports*, iv. 497.

the mucous membrane was pale throughout the entire intestine, the valvulæ conniventes looked swollen and œdematous, and the color of the membrane was dead white. The solitary glands were very distinct and prominent. Those of the duodenum were remarkably so. In cases of imperfect reaction the mucous membrane of the intestine was usually found very much congested and ecchymosed. The congested portions were sometimes granular, and apparently denuded of epithelium. The mucous surface had often a dark port-wine color, due to the extravasated blood and the hyperæmia, and here and there the surface was covered with a dirty gray membranous substance, likened to a diphtheritic deposit. I have, however, seen no decided false membrane, such as could be peeled off, as in diphtheria. The surface was also occasionally bile-stained, and the greenish-yellow color of the bile and the deep-red color of the congested surface presented a very striking appearance. The solitary glands were very prominent, and in some cases apparently enlarged." The general paleness of the intestinal mucous membrane in the stage of collapse, and its congestive redness whenever the signs of reaction have existed before death, have a very important bearing upon the pathology of this disease, for they demonstrate conclusively that the gastro-intestinal evacuations in cholera have no relation whatever to inflammation. On the other hand, they render it altogether probable that the serous flux is in the nature of a sweat, an intestinal ephidrosis.

The nature of the exfoliation found in the intestinal canal has been the subject of much discussion. As

long ago as the first American epidemic of cholera (1832–35) Dr. W. E. Horner, Professor of Anatomy in the University of Pennsylvania, described an exfoliation of the epithelial lining of the alimentary canal, whereby the extremities of the venous system of the part are denuded, as being characteristic of cholera alone. In 1849, Dr. Samuel Jackson, Professor of the Institutes of Medicine, and Dr. John Neill, Demonstrator of Anatomy, in the University, in conjunction with Dr. William Pepper and Dr. Paul B. Goddard, presented a report to the College of Physicians of Philadelphia, in which they, too, showed that the "epithelial layer of the intestinal mucous membrane was either entirely removed or was detached, adhering loosely." This important fact—the most important, perhaps, in the mechanism of cholera—was confirmed seventeen years later by the eminent pathologist Dr. Lionel S. Beale,[1] who, when referring to "the remarkable characters of the matter discharged from the intestinal tube, and to the fact that the small intestines almost always contain a considerable quantity of pale almost colorless gruel-, rice-, or cream-like matter," added: "This has been proved to consist almost entirely of columnar epithelium, and in very many cases large flakes can be found, consisting of several uninjured epithelial sheaths of the villi. . . . . In bad cases it is probable that almost every villus, from the pylorus to the ilio-cæcal valve, has been stripped of its epithelial coating during life. . . . . These important organs, the villi, are, in a very bad case, all, or nearly all, left bare, and a very essential

[1] *Med. Times and Gazette*, Aug., 1866, p. 109.

part of what constitutes the absorbing apparatus is completely destroyed. . . . . It is probable that the extent of this process of denudation determines the severity or mildness of the attack. . . . . It seems probable also that the epithelium may become detached in consequence of the almost complete cessation of the circulation in the capillaries beneath, but the death of the cells may occur in consequence of their being exposed to the influence of certain matters in the intestine or in the blood, in which case they would simply fall off."

In this connection, and as complementary of the statements now made, should be considered the further description by the same author—viz.: "Remarkable changes have occurred in the smaller vessels, especially in the capillaries and small veins of the villi and submucous tissue. The blood-corpuscles appear to have in a great measure been destroyed in the smaller vessels, and in their place are seen clots containing blood-coloring matter, minute granules, and small masses of germinal matter evidently undergoing rapid multiplication. Some of the arteries are contracted, but here and there small clots destitute of blood-corpuscles may be seen at intervals." Hence the gastro-intestinal lesions in cholera; according to their extent and degree they remove the natural obstacles to exhalation in the mucous membrane, and also, and in the same degree, prevent the absorption of the contents of the alimentary canal. It must not, however, be forgotten that this lesion is not altogether peculiar to the intestinal mucous membrane. Dr. Beale long ago called attention to the fact that in this disease

there seems to be a tendency to the removal of epithelium from the surface of all soft, moist mucous membranes, but not from the follicles of the glands. The first statement appears to be explicable by the shrinkage of all the mucous membranes during cholera collapse, for by this merely mechanical agency the inelastic epithelium must necessarily become detached. As to the second statement, the remark may be made that the whole follicular surface furnished with columnar epithelium is an absorbing and not an eliminating apparatus, and that, since its functional activity is from the beginning of the disease diminished by an inadequate blood-supply, it can have but a small and indirect share in generating the phenomena of the disease.

In his original report on the cholera in Egypt,[1] Dr. Koch describes those bacteria of a definite form which have since been so closely associated with his name. The following is his account of them: "They are rod-shaped, and belong, therefore, to the bacilli; in size and shape they most nearly resemble the bacilli found in glanders. In those cases in which the bowel showed the slightest changes to the naked eye the bacilli were found to have penetrated into the follicular glands of the mucous membrane, and had there given rise to very considerable irritation, as shown by the increase of the lumen of the gland and the collection of many nucleated cells in its interior. In many cases the bacilli had also penetrated behind the epithelium of the glands, and had proliferated between it and the basement membrane of the gland. They had, moreover,

[1] *Times and Gaz.*, October, 1883, p. 447.

collected in considerable quantities on the surface of the villi, and had often penetrated into their substance. In severe cases which had been characterized by hemorrhagic infiltration of the intestinal mucous membrane the bacilli were found in large numbers, and were not limited only to the interior of the follicular glands, but had passed into the surrounding tissues, into the deeper layers of the mucous membrane, and here and there even into the muscular coat of the bowel. The villi were also in such cases extensively invaded by the bacilli. The chief seat of these changes is the lower part of the small intestine."

In 1884, Dr. Koch, during his investigations of cholera in India, found the same bacilli in the bowel which he believed to be peculiar to the disease, and which presented the following characters: they were not straight, like other bacilli, but curved or comma-shaped; they proliferated rapidly and displayed very active movements. Bodies of persons who died of various other diseases did not present them, although abounding in different bacteria. The bacilli were not found, or only exceptionally, in the stomach, but abundantly in the intestine, and most so in the diarrhœal discharges that occurred at the height of the disease. As soon as the stools began to be fecal the specific bacilli disappeared from them. After death at the height of the disease they were most abundant in the intestinal contents, and especially in the lower part of the small intestine. When death took place at a later period none of them might be detected in the liquids in the bowel, but they would still be present, in considerable numbers, in the tubular glands. They

were not found at all in cases fatal from some sequela of the disease.[1]

The conclusions of these two reports, and of the much more detailed descriptions presented by Dr. Koch to the conference held at Berlin in July, 1884,[2] are substantially identical, and, although they have generally been accepted as furnishing a solid foundation for a pathology of cholera, they are by no means assented to by other observers even in the same field in which Dr. Koch conducted his researches. The most important document relating to the question is a *Report* presented by Drs. E. Klein and Heneage Gibbes to the government of India. Its conclusions are as follows: "(1) The statement of Koch that 'comma bacilli' are present only in the intestines of persons suffering from or dead of cholera is not in accordance with the facts, since 'comma bacilli' occur also in other diseases of the intestines; *e.g.* epidemic diarrhœa, dysentery, and in intestinal catarrh associated with phthisis. (2) The 'comma bacilli' in acute typical cases of cholera are by no means present in such numbers and with such frequency as to justify Koch's statement that the ileum contains almost a pure cultivation of 'comma bacilli.' (3) The 'comma bacilli' are not present in the tissue of the intestine or elsewhere. (4) The 'comma bacilli' in artificial cultivations carried out by one of us (E. K.) do not behave in any way differently from other putrefactive organisms. (5) Mucus-flakes of the ileum, taken out soon after death from typical acute cholera, contain numer-

[1] *Times and Gaz.*, Mar., 1884, p. 398.

[2] *Med. News*, xlv. 221.

ous mucus corpuscles, many of them filled with peculiar minute straight bacilli. The same bacilli occur also outside the mucus corpuscles. They are never missed even when the 'comma bacilli' are. (6) These small bacilli have been cultivated by one of us (E. K.), and they do not behave differently from putrefactive organisms. These small bacilli are not present in the tissues of the intestines or any other tissue. (7) No bacteria of any kind, and no organisms of known form and character, occur in the blood or any other tissue. (8) A good many experiments have been carried out by one of us (E. K.), with the following results: (*a*) Mice, rats, cats, and monkeys were fed with rice-water stools, with vomit, with mucus-flakes of the ileum, fresh and after having been kept for twenty-four to forty-eight hours. The animals remained normal. (*b*) Inoculations with recent and old cultivations of 'comma bacilli,' as well as with mucus-flakes, were made into the subcutaneous tissue, into the peritoneal cavity, into the jugular vein, and into the cavity of the small and large intestine of rabbits, cats, and monkeys; but the animals remained perfectly well and normal."[1] In confirmation of these conclusions may be cited those of Mr. Timothy Richards Lewis, who under peculiarly favorable circumstances studied the relations of the "comma bacillus" to cholera at Marseilles during the epidemic of 1884. He shows that "comma-like bacilli, identical in size, form, and in their reaction with aniline dyes, with those found in choleraic dejecta, are ordinarily present in the mouth of perfectly healthy persons."[2] At a still more recent date than the pre-

[1] *Med. Times*, Jan., 1885, p. 31. [2] *Ibid.*, Sept., 1884, p. 398.

ceding[1] Dr. Klein, with the aid of Dr. Gibbes and Mr. Lingard, published the final results of their investigation, confirming in all respects their earlier announcement; and among their conclusions is the very important one, insisted on elsewhere, that the earlier after death the examination is made the fewer "comma bacilli" were found, or, in other words, that the bacteria are not causes, but consequences, of the disease. Indeed, the mucous membrane of the ileum, in typical rapidly fatal cases, if examined soon after death, does not contain in any part any trace of a "comma bacillus." Dr. Dowdeswell, also after a critical and experimental investigation of the question, agrees with the second report of Dr. Koch in the conclusion that, "though the microbe bears some relation to the disease, it is not its actual cause."[2]

At the conclusion of a series of lectures on the morbid anatomy of cholera, M. Strauss, who was the chief of the French Cholera Commission in Egypt in 1883, combated the views of Dr. Koch. "If," he said, "the comma bacillus was the true cause of cholera, it presented the very strange peculiarity of possessing the property of provoking such grave symptoms, and such profound alterations in the blood, kidneys, etc., merely by its presence in the contents of the intestines, since it was never met with in the blood or viscera, and —in rapid cases, at any rate—it did not even invade the intestinal mucous membrane in any considerable degree. This would create for it in the history of pathogenic microbes a place quite special. . . . If the

[1] *British Med. Jour.*, February, 1885.

[2] *Ibid.*, March, 1885, p. 589.

comma bacillus were really pathogenic, and not simply a common organism which multiplied abundantly in the intestines of cholera patients because it found there a suitable cultivation medium, it would be necessary to show that it was only met with with the characteristics peculiar to it exclusively in cholera. . . . After referring to the discovery of comma bacilli in chronic dysentery by M. Malassez and in healthy saliva by T. R. Lewis, and to the manner in which Koch had dealt with the objections thus raised, M. Strauss spoke of the observations of MM. Finkler and Prior. The latter had met with an epidemic of cholera nostras at Bonn, and in the stools of one of the patients they had found an organism morphologically identical with that of Koch, and which by cultivation gave rise to spirillæ. They had forwarded a specimen of their organism to M. Pasteur, and thus he (M. Strauss) had had the opportunity of studying and cultivating it. Morphologically, it was impossible to find the slightest appreciable difference between the organism of Messrs. Finkler and Prior and the comma bacillus."[1] It is unnecessary to analyze in detail the preceding experiments and observations. They are sufficiently harmonious to warrant the belief that the essential cause of cholera is not the comma bacillus, and to sustain the conclusion which we have arrived at in a subsequent paragraph of this dissertation.

Other abdominal lesions in cholera possess a very subordinate importance. The isolated and the agminated glands are both prominent, chiefly because they are swollen by the liquid imbibed from the bowel. A

[1] *Times and Gazette*, April, 1885, p. 523.

whitish substance which they sometimes contain may perhaps be the albumen or fat which they have taken from the intestinal liquid. A very similar condition of the mesenteric glands is probably due to a like cause. The liver is pale and flaccid when death takes place in collapse, and it is also described as presenting a "dirty grayish-red, homogeneous appearance, and indistinctness of the lobular structure, as if some glutinous matter had been poured throughout the tissues of the organ" (Sutton). This appearance would seem to be due to the total suspension of the blood-supply through the portal vein.

At all stages of the disease the gall-bladder is usually found full of bile, which is apt to be dark during the collapse and more watery after reaction has commenced.

The spleen is small, pale, and, as a rule, firm, but occasionally it is soft.

The kidneys present no marked changes when death has taken place early in the attack, or at most only exhibit a lighter color than usual of the cortical substance and a darker one of the pyramids. They show that the arteries are comparatively empty and that the veins are congested. Similarly contrasted appearances are met after death from obstructive disease of the heart and other causes that produce obstruction of the venæ cavæ. In the tubules, later on, fatty degeneration of the epithelium has been observed, and some cylindrical casts. These alterations, especially of the tubules, are most marked when death occurs in the stage of reaction, and are then apt to be accompanied by more or less hemorrhagic transudation. The uri-

nary bladder is always contracted after death in collapse; after febrile reaction its mucous membrane may be more or less coated with false membrane.

The brain and the spinal marrow offer nothing peculiar; their venous systems are everywhere more or less engorged, and sometimes effused blood has been found in the spinal canal.

In the state of the respiratory organs the most important facts are that in algid cholera the lungs are always more or less collapsed, "shrunk, and small, and lying back in the chest, toward the spine," and that, so far from being congested, they are (with the exception of a small portion of their posterior part rendered dense by hypostasis) singularly bloodless, dry, and tough. As might be inferred from these conditions, they are also lighter in weight than natural. To Dr. Parkes belongs the credit of having first described this very important fact in the morbid anatomy of cholera, as follows: "In fourteen cases the lungs were completely collapsed, appearing in some cases like the lungs of a fœtus. In three cases they were considerably, in eight slightly, collapsed, and in the remaining fourteen cases the collapse was in some altogether, and in some partially, prevented by old adhesions."[1] So Dr. Sutton found that the average weight of the two lungs during collapse was about twenty ounces, and after reaction—that is, after the passage of the blood into the pulmonary artery had become completely re-established—about forty-five ounces. In the latter condition also the lungs presented the usual signs of congestion of those organs, being dark-red through-

[1] *Med. Times*, 1848, p. 378.

out or in portions only. Sometimes also they contained masses or nodules of apparent hepatization, and of these some may have undergone partial softening.

In absolute conformity with the condition of the lungs that has been described is that of the heart. If the lungs are bloodless, it follows necessarily that the left side of the heart must be empty, and almost as necessarily that the right side of the heart must be distended with blood. All careful investigators of the subject agree that such is the condition of the heart when death takes place in cholera during the stage of asphyxia. All report that the pulmonary artery is either empty or that it contains a small quantity of dark and usually of thick blood; that the right side of the heart and the coronary veins are distended with blood of the same description, while numerous ecchymoses exist along the course of the coronary veins; that the venæ cavæ are filled with half-coagulated blood of a tarry aspect; and that even the femoral and splenic veins contain similar blood. On the other hand, the left ventricle of the heart is usually contracted, and contains a very little semi-fluid blood, with perhaps a small and pale clot. This engorged condition of the right cavities and emptiness of the left cavities of the heart diminish very slowly during the passage from collapse to reaction, during which time the pulmonary blood-vessels are being gradually replenished. Besides the thick and tarry aspect of the blood above described, it has been observed that when the blood is withdrawn by means of a pipette, its globules rapidly subside and are surmounted by a transparent

serum, and that such blood may remain for a long time uncoagulated. The red corpuscles are said to be pale and viscous, but not adhesive, and the white corpuscles abnormally numerous and easily crushed. In the free intervals are observed "very pale little objects, slightly elongated and constricted in their middle," which multiplied in blood kept for one or two days at a temperature of 68° C. (100.4° F.).[1] If death does not take place until reaction is far advanced or has merged into a febrile condition, the left ventricle is usually found not contracted, and it contains a quantity of blood. The term "usually" is employed to show that even to this rule there are some exceptions, and that, as in all other diseases, the issue does not depend absolutely and exclusively upon a definite degree of any anatomical lesion, but upon the aggregate condition of all the functions upon which life depends. The pericardium, like the pleura and the peritoneum, may be covered with a saponaceous film which is albuminous.

In looking now over the field that has been traversed in the foregoing pages, and searching for some link that will unite in a consistent whole the causes, symptoms, and lesions of cholera, it is evident that only one factor can possibly be so described. That factor is the gastro-intestinal flux. This it is that produces the vomiting and the purging; that prostrates the patient and wastes away in a few hours the fullest and the firmest form; that chills the limbs and afterward the trunk; that thickens the blood so that the capillary vessels can no longer convey it, and that

[1] *Rapport sur le Cholera d'Égypte en 1883*, par M. le Dr. Strauss, etc.

spreads a cyanotic shadow over the whole surface of the body; that cuts off the supply of blood from the lungs and heart; that paralyzes the nervous system, ganglionic as well as cerebro-spinal; that obstructs the kidneys and arrests their secretion; and that, acting through the several links of this pathological chain, becomes the cause of death. But the question still recurs, What is the cause of the gastro-intestinal flux? To this also, in the light of observation, it is possible to give only one answer. It is a specific poison which originates in Hindostan, and, being taken into the stomach and bowels, not only produces in the individual the symptoms and lesions of cholera, but is capable of multiplying itself and rendering infectious the discharges from the stomach and bowels of the subjects of the disease, so that it may be transmitted from one person to another round the whole circumference of the globe. Regarding the form and nature of that poison little or nothing is definitely established, beyond what has already been stated as the result of Koch's observations. As far as they go, they harmonize with a long-prevalent opinion that the cholera-poison consists of certain microscopic germs, which, on being received into the bowels, propagate their kind and destroy the epithelium. It is believed by some that these bodies are products of the rice-plant on the banks of the Ganges, and that, having once originated the disease, the germs contained in the discharges become mixed with water or are borne upon the wind, and enter the system of new victims, who, in their turn, disseminate the plague. This theory will be further considered below.

Another view, that of B. W. Richardson, is that, "as pus undergoes changes which convert it into a septic poison, so the excreted matter from the alimentary canal is equally capable, under peculiar conditions of oxidation, of producing an alkaloidal organic poison, which, soluble in water, but admitting of deposit on desiccation," becomes the agent for disseminating the disease. In these theories a false datum and a hypothesis are offered us in place of the fact which we seek. The cryptogamous nature of the essential cause of the disease has no positive proof, but only the probability of coincidence, in its favor. There is no proof, because one after another organic form has been alleged to be the essential generator of the disease, and each has been proved to be either not peculiar to cholera or has been shown to be present in other diseases than cholera.

At the present time (1885) it is the fashion to trace every disease to specific bacteria or analogous organisms. But it may be that the occurrence of cholera only furnishes the occasion for the development of these organisms, just as a certain temperature, hygrometric condition, and deficient light and air will cause mould to form on bread and other organic substances. Long before the researches made by Dr. Koch others had been undertaken which foreshadowed his results. In 1849 a committee of the Bristol Medico-Chirurgical Society investigated the nature of cholera by means of microscopical observations, and discovered in the dejections, and described, bodies which are now known as "cholera bacilli." A report on behalf of the committee was made by Drs. Baly and Gull, who, however,

refused to recognize in these bodies a constant or characteristic constituent of the ejecta.[1] But within the same year[2] Dr. Budd is said to have claimed for these bodies a distinct relation to cholera, and his reviewer concludes that "they exist in cholera discharges, and not elsewhere." As they are figured by the original observers they certainly bear some likeness to Koch's bacilli. It appears, also, that the late Professor Pacini of Florence published in 1854 an account of the lesions found in cholera, in which he declared that "the epithelial lesion is covered by nothing but a very simple organism of extreme tenuity, which I shall call 'microbe'—a term generic and modern—and, with special reference to the disease in question, 'cholerigenous microbe.'" It is not certain, however, that this microbe was identical with that of Koch. The judgment pronounced by Dr. Beale in this question as long ago as 1866 appears now, as it did then, to approach the truth upon this point: "There is no good reason for supposing that the bacteria in such numbers in the alimentary canal in cholera have anything to do with this disease or with the falling off of epithelium from the intestinal and other mucous membranes. Bacteria are developed in organic matter which is not traversed and protected by the normal fluids of the body, and they invade the cells and textures in cholera after those cells and textures have undergone serious prior changes, just as they would invade textures removed from the body altogether. Nor would it be in accordance with known facts to

[1] *British Med. Jour.*, March, 1885, p. 589.

[2] *Med. Times*, ii.

infer that cholera was due to the invasion of some peculiar form or species of bacterium."[1]

We repeat, then, that while nothing can be simpler than the mechanism of cholera viewed as a gastro-intestinal hyperidrosis, nothing is more mysterious than the mechanism of the primary cause which gives rise to it. That its real nature has been correctly described is rendered all the more probable by the fact, presently to be insisted upon, that sporadic cholera morbus, which is always the consequence of a direct irritation of the gastro-intestinal mucous membrane, is often with difficulty distinguishable from Asiatic cholera, which, indeed, differs from the former disease chiefly by the intensity of its cause as measured by the gravity of its symptoms and by the nature of the special agent that produces it.

The above views regarding the mechanism of cholera were substantially indited before the Egyptian epidemic of 1883, but they are in accord with the more definite conclusions arrived at by the German and French commissions on the subject. Before their reports appeared, however, a communication was made by Dr. Kartulis of the Greek hospital in Alexandria, setting forth that the drinking-water and the stools and blood of the cholera patients contained, the first a mass of micro-organisms, and the others bacteria and micrococci, which, however, presented no distinctive characters.[2] The German report was prepared by Dr. Koch, the French by Dr. Strauss.[3] The former,

[1] *Times and Gazette*, Aug. 1866, p. 167.

[2] *Medical News*, xliii. 377.

[3] *Archives gén.*, Dec. 1883, pp. 713, 722.

alluding to the enormous quantity of micro-organisms found in the contents of the bowels and in the stools, did not perceive any connection between them and the phenomena of the disease. On the other hand, he did assign this relation to a species of bacterium found in the walls of the intestine, and which he compared to the bacilli of glanders. As above related, they were lodged within the intestinal glands and behind their epithelium, as well as upon the surface of the villi and within them, and sometimes even in the muscular coat. They were most numerous at the lower end of the small intestine. Dr. Koch concluded that although these bacilli, beyond doubt, are in some manner associated with the development of cholera, *they are by no means shown to be its cause, and may indeed be themselves the product of the morbid conditions belonging to cholera.* All his attempts at that time to develop cholera in animals by inoculating them with the organisms gave only negative results. The conclusions of Dr. Strauss were in entire conformity with those of Dr. Koch, but involved an additional and very important statement—viz. that the shorter and the more violent were the fatal attacks of cholera the fewer were the bacteria found in the intestine. It is evident that this fact is the very opposite of what should have been found had bacteria been essential in the causation of cholera. The more recent investigations conducted in Calcutta by Dr. Koch, which have already been cited, led him, however, to attribute to bacilli of a specific form the absolute origination of the disease. He poses the question in the following manner: Either these "comma bacilli" are a product of the cholera process,

or "the disease only arises when these specific organisms have found their way into the bowel." The former alternative he rejects, because, in his judgment, it assumes that the bodies in question must be pre-existent in every person who becomes affected with the disease —a hypothesis which he rejects, because they have never been found except in cholera. He therefore concludes that they are the cause of cholera. He points out that their first appearance coincides with the commencement of the disease, that they increase with it, and that they disappear with its decline.[1] The statement of Strauss quoted above does not, however, appear to harmonize with this conclusion, since the bacteria are said by him to have been fewest in the more violent and fatal attacks of the disease. Finally, the very positive conclusions of Drs. Klein and Gibbes are at such utter variance with the doctrine attributed to Dr. Koch that it seems no longer possible to accept the bacillar doctrine of the production of cholera. Another of Dr. Koch's remarks is also open to criticism. After showing how rapidly the cholera bacteria multiply when kept moist, he states that they die after drying more quickly than almost any other form of bacteria. "As a rule, even after three hours' drying every vestige of life has disappeared." It is evident that this statement is not in harmony with the numerous facts, several of which have been cited, that cholera fomites have preserved their infectious qualities after several weeks. Dr. Koch endeavored to produce in animals, artificially, with these bacteria, a disease analogous to cholera, but without success; and he adds, "If any

[1] *Times and Gaz.*, March, 1884, p. 398.

species of animal whatever could take the cholera, it would surely have been observed in Bengal, but all inquiries directed to this point met with a negative result." Dr. Vincent Edwards, who, however, is of opinion that the cholera poison is "not an organism, but of the nature of a chemical compound of comparatively unstable nature," reports that he produced fatal cholera in pigs by giving them the dejections of cholera patients.[1] But the *Times and Gazette* inclines to question that the pigs employed in Dr. Edwards' experiments were affected with true cholera.

DIAGNOSIS.

The most characteristic symptoms of Asiatic cholera have repeatedly been mentioned in the foregoing pages. They are rice-water evacuations by vomiting and purging, rapid emaciation of the whole body, a cadaverous hollowness of the cheeks and eyes, a livid color of the face, hands, and feet, a feeble, thready, and at last absent pulse, an icy coldness of the extremities, face, and even the breath, a loss of the elasticity of the skin, a thin and feeble voice, and intense thirst. But every one of these symptoms may occur in cholera morbus produced by a direct irritation of the stomach and bowels. It is rather their nature, we repeat, than their phenomena, that distinguishes these two affections from each other. In attempting to separate Asiatic cholera from other forms of cholera we must endeavor to dismiss from the mind the erroneous notion that

[1] *Notes on the Poison contained in Choleraic Atomic Discharges.*

the term cholera denotes a definite disease identical in its cause, phenomena, and results. It is no more a disease than dropsy or fever is a disease. It is a complex group of symptoms which have in common the fact that they proceed directly from gastro-intestinal irritation, whose degree of severity—*i. e.* the presence or absence of certain grave symptoms—and, above all, its issue, depend chiefly upon the nature and intensity of the cause of the attack, and also, necessarily, upon the degree of resistance opposed to it by the subjects of the disease. Nothing has led to more error in regard to epidemic cholera than the ignorance of this pathological fact by some and the disregard of it by others.

In the first portion of this article it was shown that the Greek, Roman, and Arabian conceptions of cholera morbus included a discharge of bile, the very symptom for the absence of which Asiatic cholera is notorious; and also that the classical cholera, or cholera morbus, ended in recovery even more frequently than Asiatic cholera terminates in death. But local epidemics of cholera morbus sometimes take place which are of a severe and even of a grave type, and which also appear to originate in some peculiar atmospheric influence, for they prevail to a limited extent and in connection with vicissitudes of weather. Still more circumscribed epidemics have been traced to unwholesome food and drink, and innumerable instances of individual attacks have been caused by irritants that are ranked as poisons and others which are reckoned as food or medicines. Now, under these various circumstances, which have in common gastro-intestinal irritation, there may be pro-

duced, if the irritation is excessive, a series of symptoms closely resembling, if not identical with, those of Asiatic cholera.

In illustration may be cited the comparatively familiar description of Sydenham.[1] These are his words: "There is vomiting to a great degree, and there are also *foul*, *difficult*, and *straining motions* from the bowels. There is *intense pain* in the belly, there is *wind*, and there are *distension*, heartburn, and thirst. The pulse is quick and frequent, at times small and unequal. The feeling of sickness is most distressing, and is accompanied with heat and disquiet. The perspiration sometimes amounts to absolute sweating. The legs and arms are cramped and the extremities cold. To these symptoms, and to others of a like stamp, we may add faintness." . . . . "As the summer came to a close the cholera morbus raged epidemically, and, being promoted by the unusual heat of the weather, it brought with it worse symptoms, in the way of cramps and spasms, than I had ever seen. Not only, as is generally the case, was the abdomen afflicted with horrible cramps, but the arms and legs, indeed the muscles in general, were afflicted also." . . . . At the risk of repetition an additional passage may be quoted from Sydenham's later definition of cholera morbus: "This is *limited* to the *month of August* or the first week or two of *September*. Violent vomiting, accompanied by the dejection of *depraved humors*, *difficulty on passing them*, *vehement pain*, *inflation and distension of the bowels*, heartburn, thirst, quick, frequent, small, and unequal pulse, heat and anx-

[1] *Works*, Sydenham Soc. ed., i. 163; ii. 8, 266.

iety, nausea, sweat, cramps of the legs and arms, faintings, and coldness of the extremities, constitute the true cholera—and it kills within twenty-four hours."

In spite of the general likeness between this description and the symptoms of Asiatic cholera, there are differences of considerable importance, which have been italicised in the quotations. These differences are such as may be attributed to the action of a harsh irritant in the case of cholera morbus, while in the epidemic (Asiatic) disease the distinctive phenomena are the result of a sudden and profuse intestinal flux. Macpherson, who had a long and extensive experience of epidemic cholera in India, after contrasting in detail its phenomena with those of cholera nostras, sums up the discussion in these words: "Cholera indica is essentially a very fatal disease, while cholera nostras is usually a mild affection and is seldom fatal, although it was called *atrocissimus et peracutus*, and has undoubtedly killed in from eight to twenty-four hours."[1] In regard to the individual symptoms this very competent reporter does not recognize a single one as being absolutely peculiar to either disease. Even the ancients already referred to, after describing bilious evacuations as being characteristic of cholera nostras, add that sometimes also they are whitish; and modern writers, both before and since the advent of Asiatic cholera in Europe, have made a similar observation. Thus, Quinquaud, in his description of cholera nostras, of which a slight epidemic occurred in 1869 at the Hospital St. Antoine in Paris, says: "The principal symp-

[1] *Times and Gaz.*, Dec., 1870, p. 725.

toms were vomiting and purging, sometimes of a bilious and sometimes of a rice-water liquid; a shrivelled and cyanotic skin, the latter appearance being sometimes strongly marked; anxiety, coldness, cramps, altered voice, and suppression of urine.[1] In 1875 thirty-three cases of this disease occurred at Valenciennes, near Paris, and its symptoms were thus summarized by Manouvriez:[2] "Repeated vomiting, first of food, and then of a dark-green liquid; diarrhœa, which was at first fecal and then bilious, but afterward serous and like rice-water; painful tension of the epigastrium and tenderness of this part; headache, cramps in the legs, suppression of urine; pallor, coldness, and dryness of the skin, especially of the limbs; pinched features, a blue circle around the eyes, a small and scarcely perceptible pulse, and a faltering and whispering voice." Yet of the thirty-three cases only two were fatal—the one a child of four years and the other an infant of as many months. The substantial identity of nature of these two local epidemics, and the almost equally close relation of their symptoms to those of epidemic cholera, must be quite apparent.

Yet the contrasts are neither slight nor unimportant; and the most striking and significant is the trifling mortality of the European as compared with the Asiatic disease, notwithstanding the grave symptoms present in the former. It may be regarded as certain, we think, that the reason of this difference of danger lies in a corresponding difference in the nature of the causes of the two forms of disease. The rapid recovery from cholera morbus produced by changes of weather,

[1] *Archives gén*, Mars, 1870, p. 308. [2] *Ibid.*, Sept., 1877, p. 298.

acid fruits, and indigestion renders it certain that no material lesion of the gastro-intestinal mucous membrane has been produced; while, on the other hand, inspection after death from epidemic cholera or by corrosive poisoning renders it equally certain that the damage to that membrane is substantial and widespread, as well as often irreparable, and that, therefore, "the powers of life that resist death" must be engaged in a very unequal and often fruitless struggle. The cramps in cholera nostras are, as a rule, less severe than in epidemic cholera, while the colicky, and in general the abdominal, pains are greater in the former than in the latter disease. The reason of this difference appears to be that muscular spasm is the natural result of depletion, whether sanguine or serous, while colic is an effect of irritation of the surface of the mucous coat of the bowel, and not of its destruction, such as occurs in epidemic cholera.

It is true only in a limited degree, and indeed only upon a superficial survey of the symptoms, that the effects of irritant poisoning are like those produced by Asiatic cholera. The analogy between the two was pointed out, among others, by Sedgwick in 1867.[1] The resemblance appeared so striking to the vulgar eye that in Paris, and perhaps elsewhere, a popular tumult followed the first violent outbreak of epidemic cholera, and it was charged that the wells had been poisoned. The cases that most resemble cholera are the following: "Acute poisoning by corrosive sublimate, by arsenic, and by mineral acids, especially nitric acid; the effects which follow the eating or

[1] *Med.-Chir Trans.*, li. 1.

drinking of poisonous animal matters, such as tainted or simply unwholesome meat or fish, and milk which has undergone some injurious but yet unknown change, decomposing vegetables, and some of the poisonous fungi, and the excessive action of certain drugs, for the most part belonging to the class of drastic purgatives," as elaterium and croton oil. The effects produced by these agents constitute a cholera morbus, and therefore resemble cholera, and have been occasionally, and almost unavoidably, mistaken for it. It is remarkable that suppression of urine may occur among them, as well as vomiting, purging, and collapse. As Griesinger and others have pointed out, the order in which the symptoms occur is a valuable, and generally an available, ground of diagnosis. In cholera, diarrhœa always occurs before vomiting, while in the various irritant poisonings mentioned vomiting precedes diarrhœa. In irritant poisoning also there is generally severe abdominal pain—not so much colicky and paroxysmal as constant and burning; the stools are not so copious as in cholera, and they do not possess the rice-water aspect, but are rather dark, bloody, and fetid, and are voided with tenesmus or with heat in the anus; and even when the urine is suppressed it is less persistently and completely so than in cholera, and attempts to void it are attended with vesical tenesmus and strangury. In a doubtful case it is important to ascertain whether a metallic or other unpleasant taste is perceived in the mouth, whether this cavity or the throat bears marks of corrosion, whether any unusual article of food has been used, etc. Moreover, it is of extreme importance to learn whether

Asiatic cholera prevails, not merely in the immediate neighborhood, but at any place from which diseased persons or infected goods may have arrived. The instances should not be forgotten in which cholera-infected clothing from Europe has developed the disease in the valley of the Mississippi. Nor should those still more numerous cases be overlooked in which travellers affected with choleraic diarrhœa have disseminated the disease at great distances from their starting-point, although unconscious of the nature of their own ailment, whose seed they were sowing along their route.

PROGNOSIS.

Like the diseases called septic, of which the eruptive fevers may be taken as examples, and also like the effects of irritant poisons, the gravity of cholera must mainly depend upon the amount and the activity of the specific poison that is received into the system. It is most probable that the cholera-poison is organic, and that it has a limited power of reproduction and term of existence, a period also of intense activity and a period of exhaustion; in a word, that either by progressive dilution as an inorganic substance or by organic senescence it finally ceases to exist. By no other theory is it possible to explain the numerous degrees of severity which cholera exhibits, from a mild indisposition to a malignant and rapidly fatal disease. On the one hand, the patients, if they may so be

called, are hardly prevented from attending to their customary occupations. They may even be able to travel and carry the disease to distant places, and so appear to justify the erroneous and irrational doctrine of the atmospheric or spontaneous origin of cholera. On the other hand, the entire apparent duration of an attack may not exceed two or three hours, during which all the distinctive symptoms of the disease may be crowded together in the most appalling forms. Such grave cases are always most numerous at the commencement of an epidemic. These statements are true not only in regard to individual cases in the greater number of epidemics, but they represent the distinctive character of particular epidemics, some of which are as remarkable for their benignity as others are for their extreme malignity. For such contrasts no plausible reason can be suggested, unless it be a difference either in the essential virulence of the morbid poison or in the dose of it imbibed. That they are due to the activity rather than to the quantity of the poison seems to be proved by the progressive weakening in the gravity of the cases; for if the quantity of the poison remained the same some malignant cases might be expected to occur even during the decline of an epidemic.

These considerations help to explain the extreme diversities of mortality in different epidemics. The extremes may be stated at 10 and 90 per cent., and they would perhaps be still wider apart if all the mild cases, which are never reported—many of which, indeed, do not even fall under medical observation—were included in the reckoning. The general or aver-

age mortality of cholera is about 50 per cent. According to Albu, the epidemics in Berlin from 1831 to 1873 gave a total of 28,753 cases and 18,916 deaths; that is, a mortality of 65.8 per cent. (Eichhorst). It should be noted that, as in other epidemic diseases, there is no uniform proportion between the extent and the mortality of cholera epidemics. Some of very limited extent have been proportionally the most destructive. It should also be remembered that the disease is far more fatal in infancy and old age than at any other period of life, and for a similar reason it is very dangerous to all who are weakened by any cause, such as an inherited morbid diathesis, a chronic debilitating disease, etc. There seems to be a doubt whether its male or female victims are the more numerous. In this connection it may be suggested that while males are more likely to contract the disease by drinking contaminated water, etc., more women are exposed to its contagion by their intimate relations with the sick, by their handling and washing infected fomites, by carrying away the cholera discharges, etc.

Undoubtedly, the class of society to which cholera patients belong is not without influence on its prognosis. Not only is the total mortality greater among the laboring classes, but the individual belonging to those classes has a less chance of recovery, because he is not apt to resort to treatment on the appearance of the premonitory signs of the disease, and because the treatment he receives is less intelligently and sedulously pursued by his physicians and friends.

In regard to the particular symptoms which are favorable or unfavorable, nothing need be added to

what has already been stated in detail, unless it be that during the height of the attack the danger is to be measured by the degree of prostration and of the stasis of the blood, and, during reaction, by the grade of the typhoid state. Gradual reaction, as denoted by the state of the skin and the pulse and a more natural aspect of the stools, is generally indicative of improvement.

Finally, a word of caution may be given to those who are apt to attribute all the favorable changes in the conditions of an epidemic to the sanitary or medicinal measures they have instituted, Cholera epidemics are remarkable for the comparatively short period of their duration, which may be stated at less than a month in the same place. Doubtless, judicious sanitation and timely treatment save a great many lives, but the qualifying fact, already insisted upon, must not be overlooked, that the mortality occasioned by the disease in a given place is greatest during the first period of its prevalence, and that thenceforth it gradually declines. Yet it is of essential significance that the disease rarely attacks a large number of persons simultaneously; the epidemic proper is usually preceded by a few scattering cases which are apt to become foci of ignition that presently unite to form a widespread conflagration. The recognition of these cases, their isolation, and the proper treatment of the localities where they occurred have frequently stamped out what might have been the commencement of a deadly epidemic.

PREVENTION.

The history of cholera demonstrates conclusively that since the disease, outside of India, never arises spontaneously, it must be more or less preventible, partly by excluding its seeds and partly by rendering the soil in which they are planted more or less unfit for their development; in other words, by the detention of suspected persons and fomites, and sanitary cordons and by various measures of local sanitation.

In regard to the former there would be comparatively little difference of opinion, at least theoretically, if both measures were alike efficacious. But there would seem to have prevailed a tendency in official quarters to undervalue the efficiency of both. Those who made and administered the sanitary laws relating to cholera seem to have forgotten the emphatic question, "What will not a man give for his life?" or at least to have considered that whatever value some men may set upon their own lives, the lives of other men become of no account when balanced against the needs, or even the conveniences, of commerce. The ethics which justified the introduction of opium into China by the English and the American gift of alcohol to the Indian to gratify a lust for lucre or for land is only paralleled by those contained in the official protests against cholera quarantines. At the International Medical Congress held in 1873 at Constantinople it was almost unanimously resolved that "the practice of (land) quarantine as now carried out ought not to be maintained, because, on the one hand, it does not constitute a real protection, and, on the other hand, *it*

is directly opposed to the interests of commerce and industry." A leading critic, in commenting upon this, remarks that if a quarantine were possible it would give no real security, because it would be evaded, just as customs laws are evaded by smuggling.[1] A logical deduction from this curious argument would be that customs laws should be abrogated. In 1880 was published the report of the German Imperial Commission on the cholera epidemic of 1873 in Germany, edited by Hirsch, from which we learn that "all the German medical experts agree in condemning the employment of quarantine, for, while largely detrimental to the *interests*, *welfare*, *convenience*, and *happiness* of a community, it is *quite inert* and *inefficient* as a safeguard against the further diffusion of cholera."[2] Whether this opinion refers only to land quarantine or not is left in doubt, but the spirit of subordinating the lives of the people to the commercial interests of a country is just the same as, and is not less worthy of condemnation than, the spirit which has more than once blinded customs officials to the disease on board of vessels from which it has afterward issued to destroy thousands of lives.

One of the most remarkable papers ever issued by the government of a civilized nation was that in which the British Foreign Office declared in 1882 that "the government of H. M. has no hesitation in declaring that no outbreak of cholera in Egypt, or even in Europe, can be regarded as due to an importation of the disease upon a vessel from India." The Sanitary Council, sitting at Constantinople, on the contrary,

[1] *Practitioner*, xii. 226. [2] *Ibid.*, xxvi. 159.

affirmed that "cholera propagates itself in the absence of quarantine measures or when these are inefficient; as, for example, in Egypt in 1865 and at Mecca in 1882, during the last pilgrimage. On the other hand, the success of quarantine is complete when it is rigorously applied, as it was in Mesopotamia in 1879 and at El Wedj and Thor in 1881. . . . What is absolutely undisputed is the fact that when cholera exists in the countries which send out pilgrims, these latter bring it into the Hedjaz. To prevent its introduction in such manner by wise regulations strictly enforced, without at the same time touching the general interests of commerce, is the duty and the aim which the International Council of Health and the administration have at heart."[1] Later, in the same year, Fauvel, in a communication to the French Academy of Sciences, confirmed his earlier statements regarding the efficaciousness of the quarantine at Suez, saying that the Indian contingent of the English army in Egypt was entirely preserved from the disease, and the pilgrim-ships from Bombay having been subjected to quarantine, the epidemic, although a violent one, completely exhausted itself.[2]

It seems to be overlooked that in national as well as in personal affairs "honesty is the best policy," and that if, instead of concealment or false statements regarding the sanitary state of ships, their passengers, and cargoes, and equally false assertions respecting the contagiousness of cholera, and a contemptuous neglect of well-tried preventive measures,—if, instead of this

[1] *Amer. Jour. of Med. Sci.*, April, 1883, p. 544.

[2] *Archives gén.*, August, 1883, p. 235.

delusive and disastrous policy, all nations had honestly carried out the rules prescribed by experience for the exclusion of the disease, and for its management after it had passed the frontiers of a country, there can be little doubt that its ravages would ere this have been confined to the region in which it originated. As we have seen, there is urged against the enforcement of a rigid quarantine by land or sea the singular argument that it has not always excluded the disease. A more logical inference would seem to be that since it succeeded, not completely, but yet partially, its inefficiency should be charged to its imperfect execution; or, even granting that the absolute exclusion of cholera is impracticable in every instance, including cases of choleraic diarrhœa, contaminated clothing and merchandise, does it therefore follow that the transit of men and things should be unimpeded? As well might it be maintained that because one or more houses cannot escape destruction by fire, therefore no effort should be made to save the remainder of a threatened city; as well might it be argued that because some men must be killed in battle, no precautions should therefore be used to preserve the rest of the army; as well abstain from all local sanitation intended to mitigate the ravages of the disease, because, do what we may, some victims it will surely have. This is taking counsel from despair; is a stupid fatalism which one might imagine to have been imported with the disease from the East; or it may be a sign of the unconscious blindness of Mammon-worshippers, who, neither fearing God nor regarding man, have as little pity for the victims of cholera, permitted, if not

invited, by them to scourge the nations, as devout Christians once felt for the negroes who were bought or kidnapped in Africa to toil and die under the lash of the slave-driver.

Probably no sanitary cordon nor any "quarantine" will invariably and completely exclude cholera, since it is transmissible by living men and by water and by fomites of various descriptions, and, worst of all, by men who neither exhibit its characteristic symptoms nor are conscious of the poison which they conceal and disseminate. But, as has already been urged, it is no argument against preventive measures that they are not absolutely perfect in their efficiency. If they sometimes succeed in arresting the progress of cholera, and if they always, when honestly executed, lessen the number of channels through which the infection can be conveyed, and thereby reduce to a minimum its fatal effects, they ought to be maintained and perfected, and not decried or abolished. It is difficult to characterize that state of mind which concludes against the use of a salutary measure because its efficiency is not absolute, the more so when it is admitted that its inefficiency is not intrinsic, but due to negligent, and even fraudulent, administration. The preponderance of official and personal authority is altogether on the side of the necessity of a quarantine, not in its literal, but in its technical, sense. The International Medical Congress of 1874 declared as follows: "Quarantine ought to be limited to the time requisite for the examination and disinfection of the ship, the crew, and the passengers; and if there be no disease on board the latter should be released immediately

after disinfection. But if there be cholera or sickness of a doubtful nature on board, it will be necessary to isolate and disinfect the ship also." The same congress, however, wholly condemned land quarantines, apparently upon the sole ground of the extreme difficulty of rendering them efficient—an argument, as before remarked, that touches not the principle of the measure, but only the manner of its execution. In this respect the congress occupied a lower position than its predecessor of 1866, which held that the futility of quarantine in "arresting the march of cholera" arose "rather from the unintelligent application of the measure than from any fallacy in its principle."[1]

It would burden this narrative even to enumerate the instances in which a strict quarantine has protected places to which cholera has been carried by sea. In the United States numerous examples might be given of seaports into which cholera was brought from foreign countries, and within whose quarantine-stations it was confined by rigid sanitary regulations; but it is sufficient to cite the case of New York, through whose quarantine at Staten Island nine-tenths of all emigrants to America have passed. Writing in 1867, Dr. Peters said: "There have been fourteen epidemics of cholera at Staten Island, and only four have reached New York." A large number of illustrations has been collected by Dr. Smart, Inspector-General, R. N.,[2] who sums up the matter as follows: "Believing that

[1] *Practitioner*, xxviii. 393.

[2] *Lancet*, April, 1873, pp. 555, 659; *Times and Gazette*, April, 1874, p. 387. Compare also Colin, *Brit. and For. Med.-Chir. Rev.*, July, 1874, pp. 42–44.

cholera has frequently been excluded from islands by quarantine, and as often introduced by its non-observance, I regard it as a truly preventive measure; but, recognizing the impracticability of exacting it under many circumstances, I would insist on the most strict isolation of all the first cases or units of disease, whether introduced from without or originating from relationship to introduced cases or persons or goods imported from infected countries."

While experience demonstrates the efficacy, and therefore the necessity, of quarantine against cholera in seaports, it has also shown that the same agent of prevention need not be invariably and rigidly applied. When quarantine meant literally a detention, and almost an incarceration, for forty days, it often failed through its very rigor at a time when proper methods of disinfecting ships, cargoes, crews, and passengers were either unknown or inefficiently applied. It is now certain that quarantine may be reduced to a fraction of its original duration, and yet possess a much greater degree of efficiency, its length depending upon the number and the sanitary condition of the crew, etc., the nature of the cargo, etc. It is evident that a ship carrying only cabin passengers is less open to suspicion than one crowded with filthy emigrants, although both may have sailed from the same cholera-infected port. A more liberal rule may govern the one than the other; and in the second case a rigid inspection and cleansing of luggage may be imperative which would be superfluous as well as vexatious in the first case. The importance of such a treatment of emigrants' effects has already been

illustrated by cases in which they caused an outbreak of cholera after having been carried from a seaport into an interior town many hundreds of miles distant.

In regard to the time during which a vessel that has had cholera on board within a week or ten days should be detained under sanitary inspection and treatment, including a thorough cleansing of the passengers and their effects, no absolute rule can be laid down; but it would appear that if no suspicious cases arise within a week, there need be little apprehension that any will occur.

The sanitary measures which should be undertaken wherever there is reason to fear an invasion of cholera are, in the first place, such as are equally appropriate in anticipation of any infectious and contagious epidemic disease, and relate especially to the removal of all sources of putrid emanations, whether in stagnant ponds, in streets, markets, shambles, sewers, privies, cellars, or inhabited rooms; for these influences, although they do not cause cholera, yet, by lowering the vitality of persons exposed to them, create an abnormal susceptibility to disease. Many instances in Europe might be cited to prove that whole cities, which in the earlier epidemics were devastated by cholera, were either spared entirely in the later ones or suffered in a far less degree. The measures which proved most efficient were an improved water-supply and a better system of sewerage; and this fact strongly corroborates the belief that contaminated water and fecal products are the principal agents in propagating this disease. In 1866 the good effects of domestic

cleanliness were exhibited in New York. The late Elisha Harris in his report as registrar of vital statistics said: "In houses and localities where well-marked first cases were not promptly treated by local cleansing and specific disinfection cholera soon gained a foothold as a local epidemic, and we have found no large group of fatal cases in which this was not true; while in a great number of instances where the disinfection was prompt and adequate the arrest of cholera in the very worst localities and the worst houses and population was immediate and final."

"In three hundred and sixty-two houses where individuals or families were smitten with cholera, but which were promptly brought under full sanitary purification, the pestilence did not extend beyond the family in which the first case occurred." Cleanliness is the best disinfectant, but during epidemics of cholera, as of other diseases, the popular faith is very strong in numerous articles called by that name. The real value of these preparations is commercial rather than sanitary, but, indirectly, they are useful by prompting those who use them to be more diligent in searching out and removing many sources of air-contamination that perhaps invite and intensify attacks of cholera.

The disinfectants in common use comprise chlorine gas, chlorinated soda, chloride of zinc, sulphate of iron, corrosive sublimate, permanganate of potassium, carbolic acid, and the fumes of burning sulphur. Some of them—and especially the chloride of zinc, sulphate of iron, permanganate of potassium, and carbolic acid—are supposed to be capable of destroying the infectious principle of the vomit and stools. Another method

is to receive such matters in vessels containing sawdust, which, after being dried, is consumed by fire; and still another is to mix them with dry earth and bury them. If they are thrown into water-closets or privies, they should have added to them a portion of sulphate of iron. Whatever has been used by cholera patients should be destroyed, unless of value, and in that case it should be thoroughly purified by hot air or boiling water and long exposure to the sun. The importance of having large and well-ventilated rooms for cholera patients is very great, but less, perhaps, for the patients themselves than for their medical attendants and nurses. All persons should be excluded from them who are not required by the duties of the sick chamber, and in case of death funeral assemblages ought not to be allowed; nor, during a cholera epidemic, ought crowded assemblies for any purpose to be permitted.

The following rules were drawn up by Drs. Koch, Skrzeczka, and Von Pettenkofer, the commission of experts appointed by the Prussian board of health:

"Cholera is propagated by intercourse between people, and the infectious material clings, without exception, to men and the articles with which they come in immediate contact. The spread of the disease will be very greatly promoted, as experience has often shown, if, on its appearance in large places, the inhabitants take to flight and spread the germ of the disease far and near. This especially dangerous exodus of the population must be severely prohibited. Instead of thus leaving the infected place, it is easier to protect one's self from cholera by a proper mode of living and

by observing the following precautionary measures, which cannot be done so well while travelling or away from home:

"Every one who would not endanger himself by receiving the germ of the disease into his house should keep away from them those who come from stricken places. As soon as the first case of cholera appears in a place the persons coming from that place must be considered as in all probability bringing the disease-germ with them.

"In time of cholera one should lead as regular a life as possible. Experience has shown that all troubles of digestion especially favor cholera. One should, therefore, particularly avoid whatever may cause digestive troubles, as excesses in eating and drinking, and the use of food not easily digested.

"Everything which causes diarrhœa should be avoided. As soon as symptoms of diarrhœa appear a physician should be sent for.

"No food should be used which comes from a house in which cholera rages. Food the origin of which is uncertain should only be used after being cooked. The use of uncooked milk is to be especially avoided.

"All water which is fouled by human waste is to be strictly avoided. Water which comes from surface-wells in inhabited places is to be regarded with suspicion, as is also water from swamps, tanks, streams, and small rivers. Water is especially to be regarded as dangerous which has been in any way contaminated by cholera dejecta. It should be particularly observed, also, that water which is used for cleaning vessels and soiled clothes is not thrown into wells and watercourses

or in their vicinity. Since it is impossible to recognize contaminated water, only water which has been previously boiled should be used. These remarks are to be applied not only to water for drinking purposes, but to that which is used about the house for any purpose, since the infecting principle may be conveyed from the human body to the water used in the kitchen for washing and cooking food and for laundry purposes.

"People are especially warned against the opinion that the drinking-water alone can act as the bearer of the infecting material, and that one may think himself completely guarded if unsuspicious or boiled water alone be used.

"Every cholera patient may be considered a disease-centre, and it is therefore advisable that the patient should not be cared for at home, but should be carried to a hospital. If this is not practicable, all unnecessary intercourse with the patient should be strictly avoided.

"No one should visit a house in which there is cholera unless his duty calls him there, nor such houses as were visited by the disease in former epidemics of cholera. Nor should one go to places, in time of cholera, in which large numbers of people are gathered (yearly at fairs, places of amusement, etc.).

"No food or drink should be taken in rooms in which there are cholera patients. Clothes or linen soiled by discharges of cholera patients should be burned or boiled immediately or placed in a 5 per cent. solution of carbolic acid for twenty-four hours. The discharges from cholera patients must as soon as possible be placed in vessels which contain a 5 per cent. solution of carbolic acid, and the vessels should be washed

out with this solution when emptied. The discharges mixed with this solution may be thrown into necessaries or water-closets, but care must be taken that the discharges are not thrown into wells or into streams the water of which is used.

"The floors and all articles soiled by cholera discharges must be cleaned with dry cloths or rags, which must then be burned or placed in a 5 per cent. solution of carbolic acid. Everything which comes in contact with the patient which cannot be destroyed or disinfected by boiling or in the carbolic solution, must be rendered harmless by means of hot steam in a special place of disinfection, or kept at least six days unused in a dry, airy place. The rooms in which there are cholera patients must, whenever possible, remain uninhabited for six days, and should be aired day and night during this time, so that they may be completely dried; and they should finally be dried by artificial heat. Those who come in contact with the patient or with the beds and clothing should thoroughly wash their hands with soap and water, and afterward, when possible, wash them with a 5 per cent. solution of carbolic acid. This is especially necessary when they are soiled with the discharges from the patient. People are expressly warned against eating when the hands are unclean.

"When death occurs, the body, whenever possible, should be removed from the house and carried to a dead-house. If the washing of the body cannot be performed in the dead-house, it should be omitted. The burial should be conducted in the simplest manner possible. There should be no attendance at the

house of death, and people should not attend the funeral.

"The clothing, linen, and other articles used by the patient or for the body should not be sent away before being certainly disinfected. It is strongly advised that when such articles are received they be sent immediately to be disinfected. Laundries should only receive from cholera cases linen which has been previously disinfected.

"Other precautionary measures than those here given against cholera are unreliable, and all persons are warned against the use of so-called preventive medicines in time of cholera."[1]

During epidemics of cholera, as of some other diseases, the liability to be attacked is greatest when the vital powers are depressed by mental or by physical causes. Hence it is desirable that one's courage and confidence should repose upon a consciousness of having done whatever is recognized as proper to ward off the disease—not by a minute, watchful, and anxious attention to rules at every step, but by such a general care of the health as good sense and experience enjoin. Undoubtedly, other things being equal, the weak, sickly, careless, and imprudent are more liable to suffer than the strong and cautious, and therefore it is incumbent upon all to maintain as high a degree of health as possible, avoiding not only all probable sources of contagion, direct or indirect, but excessive fatigue, catching cold, depressing emotions, sexual excesses, etc. During the first cholera epidemics in this country it was considered so dangerous to eat fruit

[1] *Deutsche Med. Wochensch.*, August 7, 1884.

and fresh vegetables that many persons lived entirely upon meat, rice, and bread. Such a regimen intensified choleraphobia, and was also an unsuitable midsummer diet. There is no reason to believe that any intrinsically wholesome food need be prohibited during the prevalence of cholera.

The one article of diet about which the greatest and most peculiar care should be taken is water. It is the first duty of towns supplied with water from a common source to be sure that it is, and continues to be, uncontaminated. Well-water should be used as little as possible after the disease has made its appearance, and, as an additional precaution, no water should be drunken that has not previously been boiled. Where ice can be procured it may be used to restore the boiled water to an agreeable temperature for drinking. Filtered water, provided that it be properly filtered, may likewise be regarded as innocuous.

TREATMENT.

If regard be had to the various methods and particular medicines which have been used in the treatment of cholera, it will appear that in hardly any other acute disease has a greater number or variety been employed. If, on the other hand, we endeavor to learn what measures have been really and generally curative in cholera, and what are they to which, on the occurrence of an epidemic of the disease, we may turn with confidence in their power to cure, the result of the investigation is disheartening, and adds to the accumulated proofs

that the power of medical art is exceedingly restricted. To this conclusion we must assent at whatever cost to a faith which is strong in proportion to the ignorance out of which it grows. The discovery of microbes in the discharges of cholera patients, and the conclusion reached at once, *per saltum*, that the remedy for the disease must be looked for among the agents fitted to destroy these microscopical organisms, have led to the use in its treatment of a variety of agents described elsewhere. But scientific enthusiasts are not always very close reasoners, and in this instance they overlooked a consideration which they had been reminded of by critics as competent in such a matter as Drs. T. Lauder Brunton and P. H. Pye-Smith, who say: "If cholera be caused by microbes, we must seek to destroy them in order to prevent the spread of the disease. The cure of an individual patient is, however, a very different thing, for the symptoms from which he suffers, and which are likely to bring about a fatal termination, are in all probability not due to the microbes themselves, but to the chemical poisoning which they have generated. If we could destroy the yeast-plant completely, we might entirely prevent the formation of alcohol, and thus put a stop to drunkenness, but measures calculated to destroy the plant would be of no use whatever for the purpose of restoring consciousness to a man who was dead drunk or for treating a case of delirium tremens. Unfortunately, we do not as yet know the proper means for treating a case of cholera."[1] To attempt it by the administration of the agents most capable of destroying them would be to illustrate

[1] *Practitioner*, xxxiii. 356,

anew, and even exceed, the ancient fable in which the bear while killing the fly upon his master's face crushed its features to a jelly. In like manner, Semmola of Naples maintains that the parasiticide treatment of cholera can never arrest the disease, because the efficient agents cannot be used in such quantities as will destroy the microbes without injuring the patients, and because the death of the microbes would form only a portion of the treatment, and the least important part, since (in his opinion) "the gravest symptoms of cholera are incontestably caused by a chemical principle (ptomaïne) which poisons successively the nervous centres, and is already in process of formation in the bowel when the diarrhœa announces the beginning of the attack."[1] The first proposition of this writer is as probable as the second is unfounded.

The claims of anti-bacterial agents to cure cholera have been quaintly but efficiently disposed of by Dr. Peters:[2] "In 1872, Dr. Netwetsky found bacteria, which he did not distinguish from common bacteria, in large quantities in rice-water discharges, and set about to kill them all in a rudely scientific but exceedingly practical way. He always used two drachms of rice-water discharge in all his experiments, and found that one drachm of laudanum did not kill bacteria in this small quantity, nor one drachm of tincture of nux vomica; neither did alcohol kill them; nor ten grains of quinine; nor thirty grammes of camphor; nor five or even ten drops of strong so-called carbolic acid, which is not an acid, but an alcohol; nor one drachm

[1] *Bulletin de thérap.*, cvii. 481.

[2] *Med. Record*, xxvii. 204.

of tar; nor ten grams of calomel, between the particles of which the bacteria not only lived and moved, but on the fifth and sixth days new granular masses and new crops of bacteria had formed. The same had happened with camphor. One drachm of a strong solution of chloral did not kill bacteria, and it required one drachm of chloroform and a saturated solution of sulphate of iron. If there is any truth in science or sound reasoning, all these favorite remedies may be useful in other diarrhœas and in cholera morbus, but cannot be reliable in true specific choleraic diarrhœa, and we know they all fail in fully-developed cholera."

If we consider the matter rationally, we ought not to be surprised or humiliated on account of the comparative helplessness of medicine in this disease, since, if we reflect upon it, the case is by no means peculiar or exceptional. Every disease that may become mortal occurs more or less frequently with phenomena which place it beyond the resources of therapeutics as completely as cholera is in its most malignant forms; and yet no one lays it to the charge of medicine that the various fevers, for example, are at times utterly uninfluenced by the most rational and judicious treatment. Nor does any one bring a railing accusation against medicine when accident fatally damages a part essential to life.

One accident of frequent occurrence presents a certain analogy to cholera in its effects, and that is a burn or scald involving a very large portion of the skin. In cases of this sort experience assures us that death is almost inevitable, and that the duty of the physician is to avoid officious and meddlesome treatment, and

address himself to soothe the patient's suffering and maintain his strength, if haply the powers of nature may triumph over the effects of the injury. This, too, is the lesson, substantially, which experience has taught respecting cholera. It is certain that in this disease the function of the whole gastro-intestinal mucous membrane is reversed, and that it is no longer a secreting and absorbing organ, but one almost exclusively exhaling, and that through it the liquid which is essential to carrying on the functions is rapidly running away. If the lesion on which this symptom depends is complete, if the gastro-intestinal mucous membrane has entirely lost its natural function, evidently it is quite futile to address any treatment to this organ. But if, as probably happens in a great majority of the cases, the disorganization takes place gradually, it is evident that there is more to hope from remedies when the disease is gradually developed than when it reaches its acme at a single bound and leaves no time for medical intervention. The one unmistakable lesson that experience teaches respecting the treatment of cholera is, that its success depends upon its prompt and early application. Almost as distinctly does observation teach that subsequently to the first (or diarrhœal) stage the comparative value of different methods and individual medicines is very uncertain. And, finally, it would seem that in this, as in other acute diseases, intelligent and careful nursing and regimen are quite as important as any medicinal treatment whatever. However a false notion of the power of medicine may blind us to the fact, it is none the less a fact, that if different methods of treatment

are compared, that method gives the best results which is least perturbative. For example, in England, on board of a hospital ship, were 85 cases, of which 19 treated by quinine gave 12 deaths, 12 by calomel gave 2 deaths, 12 by carbolic acid gave 3 deaths, and 37 by "Nil" gave 1 death.[1] Or, again, in 1865, at the London Hospital, 159 patients were treated—48 with a mixture containing logwood, ether, aromatic sulphuric acid, camphor, and capsicum, of whom 31 died; 56 with sweetened water, of whom 28 died; 21 with castor oil, of whom 14 died; and 20 with "saline lemonade," of whom 6 died.[2] In the last example the deaths during the use of the astringent mixture were twice as great as under sugar and water, and under castor oil twice as great as under "saline lemonade."

We shall first give an account of the management of cholera in general, and then consider some of the particular medicines used in its treatment.

The essential elements of all plans of treatment for this disease, as for so many others, are rest and abstinence. Whatever else may be done, nothing avails without them. This remark applies emphatically to the premonitory diarrhœa; if it is neglected it may readily be converted into the full-formed disease. It is therefore essential, during the prevalence of cholera, that whoever is attacked with diarrhœa should at once give up all active occupation, and confine himself to a recumbent posture and to the use of food of the blandest quality, such as mucilages and similar prepa-

[1] *Times and Gaz.*, Dec., 1866, p. 590.

[2] *London Hosp. Reports*, iii. 444.

rations, especially of rice, which, less than any other vegetable food, is liable to fermentation during digestion. It is prudent to drink no water that has not been boiled. If there is reason to believe that the bowels retain feces from before the attack, it is generally thought advisable to administer a laxative dose of castor oil, to procure the discharge of matters which would act as irritants. Except for this purpose purgatives are neither indicated nor expedient. In a large number of cases nothing more is necessary than the use of means to check the action of the bowels, and which should consist of absorbents or antacids, astringents, and opiates as they are contained in the officinal chalk mixture, with the addition of tincture of kino or catechu and a small proportion of laudanum. This medicine should be given in dessertspoonful doses at intervals of not more than an hour.

If, instead of a diarrhœa which differs from ordinary dyspeptic diarrhœa chiefly by its watery character, there should also be colic and profuse discharges, it is proper to add to the medicines just suggested some which are of a decidedly stimulant character, such as the essential oils of cajeput, cloves, cinnamon, peppermint, etc., with which chloroform, ether, or Hoffman's anodyne may be associated. At the same time rubefacient embrocations may be applied to the abdomen, which should also be compressed slightly with a broad flannel bandage. Instead of these stimulants, and perhaps more efficiently, may be used a simple epithem made by dipping a large towel several times folded in cold or cool water, applying it so as to cover the whole abdomen, and then enveloping it and the body

with a dry towel. This application is more soothing than any liniment and its action is more constant. Instead of any of these agents dry heat may be used, obtained from bags of hot salt or sand, or moist heat from thick poultices of flaxseed meal or Indian corn meal or similar substances enclosed in flannel bags and applied to the abdomen while they are as hot as can be borne. It is difficult to determine which of these applications is the most useful. But, on the whole, heat is preferable to rubefacients, and moist to dry heat. The cold-water dressing is probably best suited to young and robust persons.

It must be remembered that between choleraic diarrhœa and cholera in its complete form there are several grades, in one of the most common of which a tendency to vomit, and even a certain amount of vomiting, accompanies the diarrhœa. Anti-emetic remedies are then indicated. They may consist externally of rubefacient and aromatic applications to the epigastrium (especially the spice poultice); and it is claimed that a hypodermic injection of morphia in this part is very efficient. Internally, the best remedies are ice swallowed in small pieces and small but frequent draughts of iced carbonated water or iced champagne. Where these liquids cannot be procured, effervescing powders used in the same way form a very good substitute for them. If, notwithstanding such remedies, the diarrhœa continues or if it tends to increase, astringent and absorbent medicines may be substituted for them; for example, bismuth may be given instead of chalk, and if this also fails acetate of lead may be prescribed. The last may be used by the rectum as well

as by the mouth, but with very questionable advantage. Meanwhile, especial care should be taken to avoid giving so much of any opiate as will induce sopor or excite nausea.

Whoever has had the care of cholera patients has probably, at first, felt sanguine of success in their treatment, even after the characteristic discharges and the symptoms of collapse had set in; but a little more experience has proved their hope to be deceptive, and revealed the reason of it in the absolute suspension of the sensibility and absorbent function of the digestive canal. Hence the dismal unanimity of all medical authors, who from actual observation of cholera have declared that no treatment avails to arrest the fully-developed disease. And yet there is some encouragement in the fact that recoveries sometimes occur from even the most desperate state of collapse and under the most dissimilar methods of treatment; so that the physician is warranted in not yielding to discouragement and in cheering his patients with hope even to the end of life. The popular dread of this, and indeed of all epidemics, is sure to be exaggerated, and it therefore behooves the physician to combat the fears of his patients, and by a cheerful manner as well as encouraging words administer the cordial of hope, which often proves stronger than pharmaceutic elixirs.

It may be well to enumerate, as many do, the indications of treatment in the active stage of cholera, but they really need no such specification. It is evident that they consist in combating the symptoms—the vomiting, the purging, the debility, the cyanosis, the cramps, etc.; and the only means by which the carry-

ing out of such indications can even be attempted are neither more nor less than would be used to relieve the same symptoms in other affections. If the evacuations could be controlled, evidently the cramps and the collapse would not occur; but this essential and preliminary step cannot be secured. The medicines introduced into the stomach or rectum are not absorbed, but are speedily rejected; those which are administered subcutaneously are not taken up by the stagnant blood as freely as in other diseases; the nervous system gives little or no response to the mechanical and physiological stimulants applied to the skin. Yet, in spite of these obstacles, the physician must persist in the use of rational methods, in the hope, however faint it may be, that he may succeed in restraining, and possibly in arresting, the fatal course of the attack. For this end he has hardly any means at command except those, or such as those, which were recommended in the first stage of the disease—the anti-emetic and anti-diarrhœal medicines, which he is only too likely to see rejected as soon as administered. Yet he must not cease to allay the thirst by the repeated administration of small quantities of carbonated and cold liquids, water, or champagne wine, or morsels of ice swallowed whole. The application of pounded ice in a bladder to the epigastrium is a measure of an analogous sort, and is sometimes as efficient as generally it is soothing. In other cases the aromatic poultice seems to answer better. Of irritants little can be said that is favorable, but the combined irritant and anæsthetic action of chloroform is useful, and morphia should be applied to the epigastrium as well as given hypodermically.

If the vomiting tends to become less frequent, acetate of lead may be prescribed, in the hope that it will exert some constringing action upon the gastro-intestinal mucous membrane. The distressing symptom, hiccough, cannot with any certainty be controlled by medicine, but perhaps the inhalation of chloroform is more efficient than any other remedy, as it also is for the cramps in the limbs. For the latter purpose it is preferable to the frictions with flannel or with stimulating liniments which are generally employed. If such liniments are used, care should be taken that they do not contain ingredients that may disorganize the skin either immediately or subsequently. A dangerous compound of the latter sort introduced during the first epidemic of cholera in this country became officinal under the name of liniment of cantharides.

The loss of the water and of the salts it holds in solution in the blood is, as has now been frequently repeated, the chief pathological element of the disease, next after the conjectural cause which injures the mucous membrane of the stomach and bowels. It was rationally indicated, and therefore a method was early practised, to supply this loss by injecting into the veins a solution of sodium salts. The method was seductive as well as rational, for its primary effects were extremely encouraging; it nevertheless failed, and probably for the very reason that suggested its use. Indeed, there is no more reason, if there is as much, to suppose that a liquid artificially introduced into the blood-vessels will be retained when the natural liquor sanguinis cannot be so. Necessarily, the one will escape where the other has escaped.

Certain systematic writers prescribe a method intended, on the one hand, for reviving the animal heat, and on the other for restoring the movement of the circulation. It need hardly be remarked that the two form essentially but one and the same indication. If the circulation is restored the animal heat will revive, but not otherwise. The same treatment leads to both ends, and it consists partly, as already stated, in the use of stimulants, such as alcohol, camphor, coffee, ether, etc.; but their efficacy depends upon their being taken into the blood, and with it reaching the various nervous centres upon which the renewal of functional activity depends. Little, therefore, can be expected from them at the height of the disease—that is, in the stage of collapse—but as soon as any signs of reaction are manifested they tend to promote it, and hence may enable the functions to revive. For this reason they are adapted to persons who are feeble by reason of their tender or their advanced age, or who have previously suffered from ill-health. But if they act at all, and the more they tend to act, they must be employed with circumspection, lest they outrun the purpose of their administration and produce a violent or excessive reaction. Instead of, or in conjunction with, these internal remedies the local stimulants of the skin, already enumerated, may be used with the due precautions, and, in addition, baths at a temperature of 105° F of water alone or with the addition of salt or mustard; but all such remedies are of little avail until reaction has commenced. Before that event there is reason to believe that the cold bath is preferable, or, still better, frictions of the whole body with cold water,

or even with ice, after which the patient should be wrapped in dry and warm blankets. Yet the efficacy of this powerful agency is by no means comparable to that which it produces in the algid forms of malarial fever. The two conditions, although apparently analogous, are, in reality, very different. In the cold stage of fever the mechanism is indeed paralyzed, but none of its mechanical elements are wanting; but in algid cholera there is an actual subtraction of water from the blood, that turns it from a liquid capable of circulating through the narrowest channels into one that stagnates even in the largest vessels. In the one case force is wanting to circulate the blood; in the other there is no normal blood to circulate.

The treatment of the stage of reaction when it does not exceed a moderate degree, consists simply in strictly enforcing the rules for the patient's repose; that is to say, in intelligent nursing. Mental excitement must be forbidden, and neither medicine nor food allowed that is likely to interfere with the gradual and steady progress of convalescence. Of all articles of food, cool water is not only the most urgently desired, but is the most imperatively necessary for replenishing the emptied blood-vessels and restoring the normal functions. But unless great caution is observed it will be taken too freely and provoke a renewal of the discharges. If any food besides water is allowed, it should be of the simplest sort—of whey first, and then of milk in small quantities at a time, with lime-water if it provokes nausea or retching. Afterward thin broths may be given, also in great moderation, and by degrees farinacea in milk and in animal broths.

Only when the strength is much improved should even the most digestible meats be permitted. In proportion as convalescence is marked or interrupted by symptoms of undue reaction is it necessary to prolong and render stringent this regimen; and if those symptoms unfortunately arise which oftener, perhaps, depend upon an over-zealous stimulant treatment than upon the natural reaction of the system, they must be combated by measures which will lessen the local congestions, especially of the brain and the lungs, and also by such as will tend to prevent the system from falling into a typhoid state. For the former dry cups applied to the back of the neck, and cold lotions and affusions upon the scalp, are to be recommended, and for the latter dry cups and warm stimulating poultices upon the chest near the affected region. It is probable that the general warm bath, with cold affusion upon the head at the same time, would prove as efficient as it does in analogous states of typhoid affections. If the urinary secretion is suspended or remains scanty, there is not usually an urgent need of using means for its restoration; for that will generally occur when the blood-vessels become replenished. It should, however, be mentioned that, according to Macnamara, if the patient does not pass any urine within thirty-six hours of reaction coming on, ten minims of the tincture of cantharides in an ounce of water should be given every half hour until six doses have been taken; and the patient encouraged to drink freely of water. If this treatment does not cause urine to pass, we must, after the sixth dose, discontinue the medicine for twelve hours, and then repeat it in precisely the

same way. The dose here referred to is of the British preparation, and if the use of it were not recommended by so competent an authority its propriety might very properly be challenged.

After the cholera patient has become convalescent his restoration is very apt to be retarded by dyspeptic disorders, for which, perhaps, the best remedy is a judicious use of condiments with the food and of bitter tonics, especially quinine, colombo, quassia, etc. before meals. If there is constipation, it should be corrected by the cautious use of fruits, and, if these prove insufficient, of mild saline laxatives or small doses of castor oil or rhubarb. On the other hand, if there is a tendeney to diarrhœa, it should be met by the use of a mild laxative, such as castor oil, magnesia, or rhubarb, followed by chalk or bismuth, and the use for a time of simpler food and in less than the usual quantities.

Having thus furnished a sketch of the plan of treatment of cholera which we regard as dictated by expe rience, it may be not without some interest to consider certain elements of the method a little more fully, and criticise, in passing, some other remedies which have from time to time been proposed. The first of these is venesection. There was a time when certain physicians, carried away by conceptions of the disease evolved from their inner consciousness, maintained that it consisted essentially of a spasm of the blood-vessels, and that the natural and legitimate cure for it was to be found in bleeding. No theory is so gratuitous or absurd but cases may be found which appear to justify it, and in this instance also examples were

not wanting to illustrate at once the truth of the theory and its successful application. Longer experience, however, and a more correct conception of the disease, have long since condemned this method, which was almost as dangerous as it was irrational. If any additional argument against it were required, it would be found in the condition of the lungs after death. These organs, we have seen, are not only not engorged, but they are empty of blood, and death is due not to asphyxia, but to apnœa, when it takes place in collapse.

If ever there existed any reason for the administration of an emetic—and ipecacuanha has generally been used at the commencement of an attack of cholera—it must be looked for, not in any clinical experience of its virtues, but simply in the deplorable routine that required the administration of an emetic at the commencement of nearly all acute diseases, so that, whatever else was prescribed, the lancet and an emetic seldom failed to be so. In this case also the proofs of the successful administration of ipecacuanha were not wanting, and one might be tempted to suppose, in view of the alleged facts in its favor, that it was useful by causing an evacuation of the material cause of the disease. In 1874, Surgeon Woodhull, U. S. Army, proposed for cholera the same treatment which had been found efficacious by East Indian practitioners in dysentery, and which has been imitated in many countries. It consists, essentially, of the administration of a dose of from 20–40 drops of laudanum, or some equivalent dose of other liquid preparation of opium, followed in half an hour by from 20–60 grains

of powdered ipecacuanha, the patient meanwhile being kept as still as possible in a recumbent posture. We cannot learn that the reasons which led to the introduction of this method have been justified by its success in practice. Physicians were even to be found, of high station and character, who contended that cholera is a species of fever, and to be treated by an emeto-cathartic composed of tartar emetic and epsom salts. If the treatment had been efficient, the absurdity of the reasons for it might have been overlooked; but the one was as disastrous as the other was false. But, as usual, the facts had been misstated or misinterpreted, and emetics ceased to form a part of the systematic treatment of cholera. The idea which possessed those who advocated the use of evacuants was that there was either a poison to be eliminated from the blood or one to be expelled from the bowels. Apparently, the method was not efficacious, for the latest phase of it, the use of castor oil in acute stage of cholera, was of short duration.

When cholera first appeared in Europe the tendency naturally arose to follow in its treatment the example of the British practitioners in India. It then appeared that one of the most eminent among them, Annesley, gave a scruple of calomel, with two grains of opium, at the commencement of the attack, and repeated the dose in six or eight hours, and again upon the following day. In the decline of the disease he ordered scruple doses of calomel for the removal of a "cream-colored, thick, viscid, and tenacious matter exactly like old cream cheese, which glues the gut together and obstructs its passage." Three, four, and even five,

scruples of calomel were usually taken before this effect was produced. When it is added that this practitioner held depletion to be the capital element of the treatment, and that he was equally lavish of his patient's blood and of his own drugs, we can only wonder that any subjects of his heroic method survived. Even as late as 1885 it is certain that the delusion as to the action of calomel still survived. One physician declared, "Whenever I have been able to get it to act on the liver I have had the satisfaction of seeing my patients recover." Evidently, he was not acquainted with the existing state of knowledge, which refuses to calomel all cholagogue power whatever. The practitioner here cited relates that in one case of cholera he gave fifty grains of calomel at once, and repeated it "in equal or larger doses after every second or third evacuation. The patient eventually recovered." It is now conceded by all enlightened physicians that mercurials in large or in ordinary doses are worse than worthless in epidemic cholera. In 1832, Dr. Ayre of Hull, Eng., proposed another method of using calomel, to which he adhered in treating this disease. It consisted in the administration of very small doses of calomel at short intervals, and with each of the first doses a few drops of laudanum. Such a method, if not carried too far, certainly has the merit of sparing the patient a great deal of the perturbative treatment against which we have, in the preceding pages, protested. But that was not at all the notion of its proposer. He claimed for it positive and active virtues. He stated, as the fundamental ground of his plan, that

"the primary and leading object of the treatment must be to restore the secretion of the liver." He did not in the least doubt that he was able to do this by the administration of mercury—not, indeed, by a direct action upon the liver itself, but indirectly and sympathetically through the stomach, and by the healthy and specific stimulus imparted to it, by which the due secretion of the bile is promoted. It is, indeed, difficult to conceive of any stimulus that calomel could impart to the stomach that would not be equally given by any other non-irritant and insoluble powder —subnitrate of bismuth, for example. Indeed, Ayre himself relates the case of a man who in an attack of cholera took during three days no less than five hundred and eighty grains of calomel, and recovered without any soreness of the mouth. But the plan which he finally elaborated was different. It was to give small doses of calomel repeatedly—in the premonitory stage one grain every half hour or hour for six or eight successive times, or, if this failed, every five or ten minutes—and in the stage of collapse one grain and a half every five minutes. In a few cases of extreme severity two grains of calomel were given every five minutes for an hour or two, and then the ordinary dose of one grain was resumed. But this was not all: with every dose of calomel was associated one, two, or three drops of laudanum, so that if these doses were repeated frequently the patient received a very efficient amount of the narcotic during the attack. Indeed, Ayre attributed to it the virtue of sustaining the vital powers under the depressing influence of the disease, and of removing or abating the cramps, as well as of

detaining the calomel in the stomach.[1] From the preceding account it follows that the treatment of cholera by small doses of calomel with laudanum is founded on an erroneous assumption of the mode of action of calomel, and that whatever efficacy the plan of treatment may possess may with more justice be attributed to the opium, whose effects we know, than to the calomel, whose action, so far as it is known at all, has no conceivable relation to the disease for which it was given. However this may be, if the results of Ayre's treatment are compared with those of other plans, it exhibits very little if any superiority. In the report of the cholera committee of the College of Physicians, London, made in 1853, we find the statement that in 725 unequivocal cases treated on Ayre's plan the deaths were 365, or about 50 per cent., and also the following commentary: "In general, no appreciable effects followed the administration of calomel, even after a large amount in small and frequently-repeated doses had been administered. For the most part, it was quickly evacuated by vomiting or purging, or, when retained for a longer period, was passed from the bowels unchanged. Salivation but very rarely occurred, and then only in the milder cases. We conclude that calomel was inert when administered in collapse, and that the cases of recovery following its employment at this period were due to the natural course of the disease, as they did not surpass the ordinary average obtained when the treatment consisted in the use of cold water only."[2] It is of interest to compare

[1] *A Report on the Treatment of the Malignant Cholera*, Lond., 1833.

[2] Dr. Gull's *Report*, p. 177.

the mortality of 50 per cent. above stated to have occurred under this sort of calomel treatment with the mortality noted at the London Hospital under various kinds of treatment, including the administration of calomel in doses varying "from five to ten and twenty grains every quarter, half, one hour, two, four, etc." Out of 509 cases, 281 were fatal, or 54.9 per cent.[1]

Every disease in which exhaustion and coldness occur is sure to be treated more or less actively with alcohol, but in the collapse of cholera, as in the cold stage of fevers, it is generally useless, and sometimes hurtful. We believe that the following protest of Macnamara is sustained by almost universal experience: "I would here enter an earnest protest against the use of brandy or any alcoholic stimulant in this [the second] stage of cholera. I believe these, both theoretically and practically, to be the cause of unmitigated evil. I simply, therefore, mention brandy, champagne, and the like in order to condemn their use most emphatically in cholera; according to my ideas and experience, it is almost impossible to hit on a more detrimental plan of treatment than that usually known as 'the stimulant' in this form of disease."[2] It is true that apparent dissidents from this judgment may be found, like Playfair, a deputy inspector of hospitals in Bengal, who even circulated printed directions for the treatment of the first stage of the disease by means of brandy or strong rum, cayenne pepper, and laudanum, and had entire confidence in the efficacy of the method.[3] Dr. Macpherson, inspector-

[1] *Lond. Hosp. Reports*, iii. 437, 441.

[2] *Op. cit.*, p. 456.

[3] *Edinburgh Med. Jour.*, xix. 471.

general of hospitals, also, after comparing the results of a stimulant treatment with those of other methods, reaches the conclusion that the mortality-rate of cholera is affected neither by the moderate nor by the excessive use of alcohol.[1]

Dr. B. W. Richardson, whose judgments always carry weight with them, holds that no good whatever follows the use of alcohol in cholera, and that the local irritation it causes excites vomiting, induces febrile excitement, and favors after-prostration. He holds that creasote in small repeated doses, in combination with opium and camphor, checks the choleraic discharge, relieves the spasm, and "is the most demonstrably curative" of any remedy he has known.[2] Surgeon-General John Murray advocates the use of a five-grain pill containing one part of opium, two parts of asafœtida, and three parts of black pepper.[3] M. Cunéo, naval surgeon-in-chief at Toulon, suggests a mixture of ether, laudanum, and extract of rhatany in an aromatic vehicle.[4]

Upon no other point in the treatment of cholera is the agreement of physicians more complete than upon the use of opiates in the early stage of the disease. The premonitory diarrhœa has always been treated by opiates alone or associated with astringents. Probably the best rule is to give from twenty to thirty drops of laudanum, or an equivalent dose of some other liquid preparation of opium, in a little brandy and water, and repeat the dose as often as a stool is voided. Opiates

[1] *Med. Times and Gaz.*, Jan., 1870, p. 62.

[2] *Ibid.*, Aug., 1883, p. 211.

[3] *Ibid.*, Aug., 1884, p. 254.

[4] *Bull. de thérap.*, cvii. 56.

have also been generally employed to mitigate the symptoms of the fully-developed disease. But, like all other medicines introduced into the stomach or rectum, they are apt to be rejected, and even if they are not, their absorption is very doubtful, so that at the height of the attack they must be considered as nearly if not quite useless. When the vomiting and purging begin to subside and reaction is about to commence, small and repeated doses of opiates undoubtedly tend to lessen the evacuations; but great caution must be observed not to exceed the due degree of stimulation, lest a dangerous state of narcotism or collapse be induced. It might be supposed that the hypodermic use of morphia would be less open to objection than its administration by the stomach; but it is to be remembered that the suspension of gastric absorption is only a part of the similar condition affecting the whole circulatory system, and that the stagnation of the blood in the systemic veins prevents the absorption of medicines administered subcutaneously perhaps as completely as the state of the gastric blood-vessels interferes with their absorption from the stomach itself. In point of fact, the utility of opiates at any stage of cholera after the first is not easily determined, for nearly always they are associated with other medicines, and especially with astringents. In this disease, as in others that involve life, we are seldom at liberty to test the powers of individual medicines, but are bound to endeavor to save life by associating those which seem to be required for the purpose. Opiates, then, are nearly always given in conjunction with astringents or stimulants during the first (or diarrhœal)

stage of the attack, but after vomiting is added to diarrhœa and a tendency to collapse is manifested they are at least useless.

The patient, it has already been said, should be disturbed as little as possible, and hence, if he becomes restless, and especially if he is rendered so by pain, he should be tranquillized by means of anæsthetics. Chloroform has generally been employed, and is best administered on the first accession of cramps. Much pain, with muscular fatigue and depression, is thus saved, and the inhalation of the medicine may be repeated as often as the pain threatens to return. No doubt other anæsthetics, and especially ether, would answer the same purpose.

Camphor has been claimed to be a valuable medicine in cholera, but there is no clinical evidence that it is so. Indeed, the only series of cases in which it was mainly depended upon gave a large mortality.

Acids have been employed in cholera, but chiefly on theoretical grounds, "in the hope of destroying the specific cholera process going on in the intestinal canal" (Macnamara). It is hardly necessary to discuss so vague a reason. What specific process is going on? What relation to it has the administration of acids? And, after all, only the hope is held out of destroying the hypothetical morbid process. The reaction of normal stools is usually acid, but sometimes it is neutral or even alkaline. In other acute bowel complaints with profuse diarrhœa they are acid, as in cholera infantum, but in epidemic cholera they are alkaline, because they consist chiefly of the water of the blood. It is far from proven that mineral acids can be useful

merely by reversing the reaction of the stools. Far more probable is it that, in so far as they are of use, it is because they act as astringents upon the digestive mucous membrane. This may be inferred from the fact that, according to the advocates of these medicines, it is always difficult, and is often impossible, to acidify the stools in cholera. Moreover, it must be remembered that, like other medicines, the greater part of them are rejected by vomiting. If, then, mineral acids tend to lessen the diarrhœa of cholera, they act by their astringency and not by their acidity. Diluted or aromatic sulphuric acid may be given in the dose of from two to thirty minims, at intervals of an hour, in acid water or carbonated water, or diluted nitric acid, in doses of from twenty to fifty minims, at the same or somewhat longer intervals.

Intravenous injections were used in England during the first epidemic of cholera in 1832–33, but their results were regarded as unfavorable; subsequently, in 1849, they were tried with somewhat better success, and in 1867 the effects were still more encouraging. The liquid employed on the last-mentioned trial consisted of chloride of sodium 60 gr., chloride of potassium 6 gr., phosphate of sodium 3 gr., carbonate of sodium 20 gr., alcohol 2 drachms, and distilled water 20 ounces. The alcohol was added only when the liquid was about to be used, and the temperature of the latter was not allowed to exceed 110° F. or fall below 100° F. The liquid was contained in a zinc vessel holding about eighty ounces, with a lamp underneath, a thermometer hanging within, and a tap near the bottom, from which proceeded an india-rub-

ber tube four feet long, with a silver nozzle at its end. The fluid was allowed to enter the vein by the force of gravity. If difficulty was experienced in introducing the nozzle, the vein was freely exposed, supported on a probe, and incised longitudinally. It was found that the success of the operation depended greatly upon having an ample supply of the solution prepared, so as to repeat the injection as often as might be found necessary. Mr. Little, who practised this method in numerous cases, stated as follows: "When a patient has been long pulseless clots form in the heart, and, as I have seen, extend into the larger veins. In one case the fluid would not flow in, and only distended the veins of the arm injected. After death clots were found extending from the heart into the axillary vein."[1] Five out of twenty apparently hopeless cases recovered under this treatment. The first effect of the injection was to revive the pulse, which had ceased to be felt; the voice also was restored, the color and expression improved, the cramps were relieved, the temperature rose, and the patients became convinced that their recovery was assured. A profuse perspiration and a severe rigor accompanied these symptoms. The rigor was evidently a nervous phenomenon, and not a chill, for it occurred when the temperature was rising. Other cases might be cited which unquestionably owed their recovery to this mode of treatment. It is true, however, that much more frequently it failed of success; and probably not only because the injection could not reach the heart, but because, having permeated the blood-vessels of

[1] *London Hosp. Reports*, iii. 470.

the whole body, it escaped, as the serum of the blood had done, from the damaged intestine. Nevertheless, it would seem that an expedient which in a certain proportion of cases has been quite successful might yet be rendered more certain in its results if the operative procedure were perfected. Nicolas Duranty of Marseilles states that he fully employed this method, but unsuccessfully.[1] It is true that all of his patients were in the stage of collapse, and although in nearly all of them a decided improvement took place immediately after the injection, the fatal issue was not prevented. Hayem suggests the following as a suitable liquid for this purpose: ℞. Distilled water, 1 liter: pure chloride of sodium, 5 grams; pure sulphate of sodium, 10 grams. Filter the solution, and heat it in a sand-bath to 100° F. The quantity for one injection is from two to two and a half liters, which is administered by degrees in the course of ten or fifteen minutes by means of a transfusion syringe.[2] According to Kronecker, 75 centigrams of pure chloride of sodium in 100 grams of water forms a solution of the proper strength. In a debate upon this subject in the Berlin Medical Society, Guttmann stated that he had made use of saline injections into the veins in 4 cases, all of which ended fatally.[3] In 1866, during an epidemic of cholera at Berlin, Fraenkel employed injections into the connective tissue of a solution of salt in water, but without the slightest advantage,[4] and probably without being acquainted with this record. In 1884, Dr. S. S.

[1] *Bull. de thèr.*, cvii. 247.

[2] *Archives gén.*, Dec., 1884, p. 752.

[3] *Bull. de thérap.*, cvii. 476.

[4] *Ibid.*, cvii. 477.

Todd[1] suggested a hypodermic injection of water to supply the intestinal waste. He proposed a solution containing a small quantity of chloride of sodium and chloride of potassium, and "such an amount of alcohol as may be deemed requisite." Just previously, Samuel had recommended multiple injections into various regions of the body, and during the whole of the stage of collapse, of solutions containing 6 grams of common salt and one gram of carbonate of sodium dissolved in 1000 grams of distilled water;[2] and about the same time Luton advocated a similar measure, and used a solution of sulphate of sodium of the strength of one-tenth, injecting deeply into the flesh of the buttocks about an ounce and a half of the solution at a time.[3]

Cramps in the limbs may be lessened by active friction and shampooing, but there is no clinical reason for believing that these measures tend to restore the circulation. Equally ineffectual are other means used for communicating heat to the algid body and thereby reviving its functions. It is true that some physicians found that warm baths, at from 90° to 104° F., gave relief to the cramps and restored the failing pulse. In most cases the calming influence of the bath was noted, but it does not seem to have been curative or to have diminished the mortality-rate.[4] It should not be forgotten that the patient has no perception of his coldness. In all analogous conditions, as has already been remarked, such as frostbite and the cold stage of periodical fevers, cold, and not heat, promotes reaction.

[1] *Jour. Amer. Med. Assoc.*, 3, 152.

[2] *Bull. de thérap.*, cvii. 564.

[3] *Ibid.*, cvii. 124.

[4] *London Hosp. Reports*, iii. 445; *St. Bartholomew's Reports*, iii. 190.

Still more injurious, if possible, than hot applications are irritants and stimulants after the stage of collapse has set in. Not only are they absolutely futile for restoring the animal temperature, but they are liable, unless very cautiously used, to produce intractable sores upon the skin if recovery ensues. It should also be remembered that the cholera patient's exhaustion is exceptionally great, and is apt to be increased by the officiousness implied in the use of many stimulating agents.

As early as 1832 a marked advantage was ascribed to the use of cold affusions in cholera.[1] One of the physicians of the cholera hospital of Berlin said: "In these living corpses which are struck with asphyxia, lying cold and powerless, external and internal medicines cease to stimulate; no steam apparatus, no warm bathing, no friction, no irritant, avails." The condition is comparable to that in approaching death by cold, in which friction with snow is well known to be the proper remedy. Cold affusions were employed in the second stage of the disease. If the pulse revived, the affusions were continued in a tepid bath, after which the patient was put to bed and gently rubbed with cold flannels. Internally, ice-water was freely administered. Labadie-Lagrave[2] refers to forty cases treated in this manner, with only seven deaths. Yet the cold-water treatment does not appear to have commended itself to physicians generally. Evidently it does not meet the prime indication, which is to restore the wasted waters of the blood and retain it in the blood-vessels.

[1] Ainsworth, *Pestilential Cholera*, 1832.

[2] *Du Froid en Thérapeutique*, 1878.

Cold water ought to be given freely, but in small quantities at a time, to assuage the thirst that exists in every stage of cholera, and especially in collapse. Nor should it be withheld because it will presently be rejected, for not only does it produce a grateful sensation in the mouth and throat, but it renders the act of vomiting easier. Yet, to some extent at least, the thirst may be allayed by rinsing the mouth and throat with cold water. Iced water is preferable to ice used for the same purpose, for the latter, by its relatively intense coldness, irritates and dries the mouth. Fragments of ice swallowed whole allay the burning heat in the stomach.

On the hypothesis that the cholera poison consists of organic germs various antiseptics have been employed in this disease. Permanganate of potassium was fortunately excluded from the list, on account of its corrosive action, but, unfortunately, carbolic acid was conceived to possess virtues that rendered it an eminently suitable remedy, and creasote, which resembles it very closely, was presumed to possess corresponding virtues. Then sulphurous acid and the sulphites, which for a time were warranted to destroy every species of germ, were confidently appealed to to stay the progress of cholera, and it was at one time even a matter of dispute whether sulphite of sodium or sulphite of potassium was the more efficacious. In truth, all of these medicines were useless, even when they were not mischievous. It may be mentioned, in conclusion, that some physicians have alleged that the inhalation of oxygen gas is beneficial in this disease.

Cholera has never prevailed in any country without giving rise to extraordinary theoretical and practical divagations. One physician in the earliest American epidemic gravely proposed, as the best mode of checking the diarrhœa, to plug the anus with a soft velvet cork. Recently, French and also Italian physicians have discovered that astringents, and especially tannin, are the proper and physiological antidotes to the disease. An English practitioner suggested that the "blood may be kept circulating by putting the patient on his back on a board and keeping up a rocking, see-saw, to-and-fro movement from eighty to one hundred times a minute." Another had the revelation that the disease is essentially a "paralysis of the sympathetic nerve and want of performance of the organic functions, with deficient vitality of the mucous membranes," and that its proper remedies are "bleeding, turpentine, and cool drinks, without heat and stimulants;" and to this remarkable doctrine a well-known physician gives his adhesion, thus: "The cause, I firmly believe, is an union of the poison with the sympathetic."[1] Still another discovered that the disease is a spinal disorder, and is to be treated by the application of ice-bags to the spine. Were not the evidence so palpable, it would hardly be believed that such irrational ideas should have been published concerning a disease which had then been under observation by the whole medical profession in Europe and America for more than thirty years, and in Asia for a much longer period.

The most important lesson to be drawn from this history of the treatment of epidemic cholera is, that the

[1] *Times and Gazette*, Aug., 1866, p. 209; *ibid.*, Nov., 1866, p. 555.

arrest of the disease in the diarrhœal stage is comparatively easy, and that in the stage of collapse its cure by any means whatever is altogether an exceptional occurrence.

May 18, 1885, the following telegrams were published in the daily newspapers: "Madrid, May 16.—Over 4700 persons have been inoculated with cholera microbes by Dr. Ferran, in the province of Valencia, as a preventive of the disease. The new system is said to be entirely successful, and the epidemic is disappearing. Dr. Ferran intends to visit England in a few weeks." "London, May 17.—The Government will send a medical mission to Spain to test the results of the system of inoculation with cholera microbes."

If the doctrine which has been maintained in this essay as the true explanation of the phenomena of cholera and the results of its treatment be correct, it follows that the alleged results of cholera inoculation are deceptive and erroneous. To assume that cholera bacilli introduced into the blood can have any influence in preventing the action of the cholera poison upon the stomach and bowels is unscientific and illogical. For if there is one fact settled in the pathology of cholera, it is that its specific germ acts primarily and chiefly upon the gastro-intestinal mucous membrane; and hence that the symptoms of the disease are all of them due to that action as their primary cause.

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